ECONOMIC REVIEW
December 2020

National Bank OF BELGIUM
Eurosystem

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Contents

Economic projections for Belgium – Autumn 2020

- As elsewhere, the COVID-19 pandemic and the various containment measures have caused a drop in Belgian GDP that is unprecedented in the post-war period, even though current statistics suggest that the decline was somewhat less steep than initially feared
- Despite the strong rebound after the spring, the economy is currently still way below its pre-crisis level and the recovery lost traction over the summer, but the second lockdown appears to have a more limited impact on economic activity
- The decline of 6.7 % in annual terms in 2020 should be followed by a gradual recovery with above-potential growth in the 2021-2023 period
- The pre-crisis level will only be reached again by the fall of 2022
- Private consumption picks up quite quickly (due to the normalisation of the saving ratio and rising income growth), while business investment takes longer to recover
- The COVID-19 impact on the labour market remains more limited than that on activity but the unemployment rate rises to some 7 %
- Core inflation is not affected much and continues to trend slightly upwards
- Wage costs are projected to rise quite rapidly in the coming years, fuelled by the indexation mechanisms
- The budget deficit widens to more than 10 % of GDP this year but, more importantly, stays at around 6 % of GDP by the end of the projection horizon
- The risks surrounding the outlook remain elevated and largely depend on the health situation and the timeline for the implementation of an effective medical solution
- As usual, the projections only take into account government measures that have been decided and are likely to pass the legislative process and were announced in sufficient detail at the cut-off date (25 November 2020). Additional government measures could affect the growth outlook but also the public finance projections.

Introduction

The macroeconomic projections for Belgium described in this article are part of the joint Eurosystem projections for the euro area. That projection exercise is based on a set of technical assumptions and forecasts for the international environment drawn up jointly by the participating institutions, namely the ECB and the national central banks of the euro area. The cut-off date for the Belgian projections was 25 November 2020. The baseline projections for Belgium are discussed in detail. While the Eurosystem has also developed two risk scenarios (one better and one worse than the baseline), no such scenarios for Belgium are presented here as they may not give a fully accurate picture of the true uncertainty around the baseline projections. Instead, individual risks are discussed in the final section of this article.

1. The COVID-19 containment measures caused a massive drop of global GDP and trade

The COVID-19 pandemic and especially the exceptional containment measures taken by many countries to limit the spread of the virus profoundly affected the global economy in the first half of the year. As restrictions were gradually eased, economic activity rebounded quite swiftly from late spring onwards. While, all in all, global output in the third quarter reached a level that was somewhat higher than expected, *inter alia* due to positive data surprises in the United States and China, the recovery was in most cases still far from complete. In addition, as COVID-19 infections flared up again after the summer, in Europe in particular, containment measures have been re-introduced in several countries and are likely to weigh on the recovery or reduce activity in certain countries again.

According to the current Eurosystem assumptions, global activity (excluding the euro area) should contract by 3 % in 2020. This is somewhat less than what was foreseen in the June 2020 Eurosystem projections but still dwarfs the 2008-2009 Global Financial Crisis in terms of impact on world growth. Global activity is then projected to increase by 5.8 % in 2021 and 3.7 % on average in 2022 and 2023. However, the strength of the recovery remains very uncertain and obviously crucially depends on the further COVID-19 developments. Moreover, the confinement measures are likely to have inflicted some persistent damage on the global economy. Viable businesses have collapsed during the lockdown or are at risk of doing so in the near future, unemployment is likely to be structurally higher than before the crisis, while consumer behaviour and preferences may have changed and international trade may not fully recover anytime soon.

On the trade side, global real imports (excluding the euro area) are projected to contract by more than 9 % this year, before increasing by 7.1 % in 2021 and by 3.9 and 3.4 % in 2022 and 2023, respectively. This scenario implies that the COVID-19 crisis does have a lasting impact on trade, which will only regain its pre-crisis level in the course of 2022. In addition, the assumed trade rebound is subject to downside risks, as the COVID-19 crisis may prove to be a game-changer for globalisation, possibly leading firms to rethink their production networks in favour of reshoring part of their operations in order to limit supply risks.

As regards the future EU-UK relationship, no substantial progress had been made in the negotiations before the cut-off date of the current projections. Hence, it was decided to switch to a no-deal scenario and the trade assumptions no longer incorporate a CETA-like free trade agreement by the end of the transition period on 31 December 2020, as was the case in the previous Eurosystem projections. Instead, it is assumed that EU-UK trade relations will simply be based on the WTO Most Favoured Nation principle. This is in line with the assumption in the EC's Autumn 2020 macroeconomic projections, for example, but the impact on UK growth in 2021 is estimated to remain generally limited (at less than 2 percentage points).

Table 1

The international environment

(annual percentage changes)

	2018	2019	2020 e	2021 e	2022 e	2023 e
World (excluding euro area) real GDP	3.8	2.9	–3.0	5.8	3.9	3.6
World (excluding euro area) trade	4.7	–0.4	–9.2	7.1	3.9	3.4
Euro area foreign demand [1]	4.0	0.6	–10.7	6.6	4.1	3.2
Belgium's relevant export markets [1]	3.9	1.8	–10.7	6.8	5.3	3.5

Source : Eurosystem.

1 Calculated as a weighted average of imports of trading partners.

As usual, the profile of world trade determines the growth path of euro area foreign demand and Belgian export markets, with the latter being an important element for the macroeconomic projections for Belgium in the medium term. Compared to the NBB's June 2020 projections, Belgian export markets should drop somewhat less in 2020 due to some positive data surprises in the first half of the year. However, trade growth has been revised down significantly for 2021 – partly as a result of the aforementioned change in the Brexit assumption – and, to a lesser extent, for 2022.

2. The euro area economy should recover further in the coming years

The euro area economy registered a strong, yet incomplete rebound after the record decline in the first half of the year. The recovery lost traction towards the end of the third quarter and the resurgence of the pandemic and the new containment measures, as well as the assumed no-deal Brexit continue to cloud the short-term outlook. At the same time, the recent news regarding the development of COVID-19 vaccines lends some support to the Eurosystem baseline assumption that an effective medical solution will be available in the first half of next year and will be fully implemented by mid-2022. Under this key assumption, the euro area economy should continue its gradual recovery in the following years on the back of strong monetary and fiscal policy support, the latter partly coming from the Next Generation EU funds.

Real GDP should post strong growth in 2021 and 2022 before decelerating somewhat in the final year of the projection period. While the pandemic will result in some persistent scarring compared to a no-COVID scenario, the recovery will bring euro area GDP back to its pre-crisis level by mid-2022. It will be mostly drive by domestic demand, as private consumption will be fueled by the dissipation of uncertainty and, hence, the return of the household saving ratio from the record highs in 2020 to more normal levels.

Table 2

Eurosystem projections for the euro area

(percentage changes compared to the previous year, unless otherwise stated)

	2018	2019	2020 e	2021 e	2022 e	2023 e
Real GDP (contributions in percentage points)	1.9	1.3	–7.3	3.9	4.2	2.1
of which:						
Domestic demand (exclude changes in inventories)	1.7	2.3	–6.3	3.9	4.5	2.0
Net exports	0.2	–0.5	–0.6	0.3	–0.4	0.0
Inflation (HICP)	1.8	1.2	0.2	1.0	1.1	1.4
Core inflation [1]	1.0	1.0	0.7	0.8	1.0	1.2
Domestic employment	1.6	1.2	–1.8	–0.9	1.8	1.0
Unemployment rate [2]	8.2	7.5	8.0	9.3	8.2	7.5
General government financing requirement (–) or capacity [3]	–0.5	–0.6	–8.0	–6.1	–3.9	–3.0

Source: ECB.

1 Measured by the HICP excluding food and energy.

2 In % of the labour force.

3 In % of GDP.

Inflation has dropped below zero in recent months but should bounce back relatively quickly as base effects from the past strong decline in energy prices unwind and indirect tax cuts are reversed in certain countries. Towards the end of the projection period, accelerating food prices should also push up euro area inflation. More fundamentally, core inflation is set to recover slowly from the current trough as the recovery gains traction. However, at 1.2 % in 2023 it is projected to stay well below 2 %.

While the massive government support measures and the short-term working schemes in particular have limited the damage on the labour market for now, unemployment is set to rise more strongly in 2021. However, the negative impact on the labour market remains more muted than that on euro area GDP and net job growth should turn positive again as of 2022 already.

The average budget deficit in the euro area worsens dramatically this year, to 8 % of GDP in 2020. Even though this mostly reflects the temporary support measures, as well as the dramatic fall in GDP, the pandemic also has a lasting negative impact on public finances. The projected improvement in the coming years should still leave the deficit at 3 % of GDP in 2023, which is five times larger than the pre-crisis level.

3. In Belgium, the recovery lost traction in the summer but the second lockdown has a more limited direct economic impact

As was the case in the whole euro area, the initial COVID-19 wave and the strong lockdown measures crippled the Belgian economy in the first half of the year. By mid-2020, economic activity had dropped by nearly 15 % compared to the last quarter of 2019. As for other countries, the negative impact was somewhat smaller than in the initial projections of the Bank and other institutions. In addition, according to the latest statistics, the rebound after this first lockdown was quite strong : the National Accounts Institute has recently revised its flash estimate for quarterly growth in the third quarter up from 10.7 % to 11.4 %.

All in all, this left Belgian GDP at a level that was still about 6 % lower than its normal path[1]. In other words, the rebound was only partial. Certain industries had not fully recovered from the COVID-19 downturn, partly due to the need to comply with social distancing measures, and because a number of restrictions (e.g. for large events) remained in place. Moreover, high-frequency indicators such as the NBB's business and consumer confidence indicators, as well as the information gathered from firms by the surveys conducted by the Economic Risk Management Group (ERMG)[2], suggest that the recovery lost steam over the summer, well before the second COVID-19 wave started to materialise.

By mid-October, the number of infections and hospitalisations had again increased strongly and new nationwide containment measures were introduced : bars and restaurants were closed and non-essential shops had to follow suit in early November.

The most recent ERMG survey, conducted from 2 November onwards, shows that sales by Belgian companies worsened again during the second lockdown, although the direct impact appears to be more limited than that reported in spring. This is due to a number of reasons. First, the economy had not yet fully recovered and, hence, the lockdown losses from a forced closure are smaller. Second, apart from the closure of certain businesses, there were fewer constraints for the economy as a whole than in the spring : more shops have remained open and, especially, despite the fact that sick leave rose somewhat (mostly due to the quarantines), the construction and

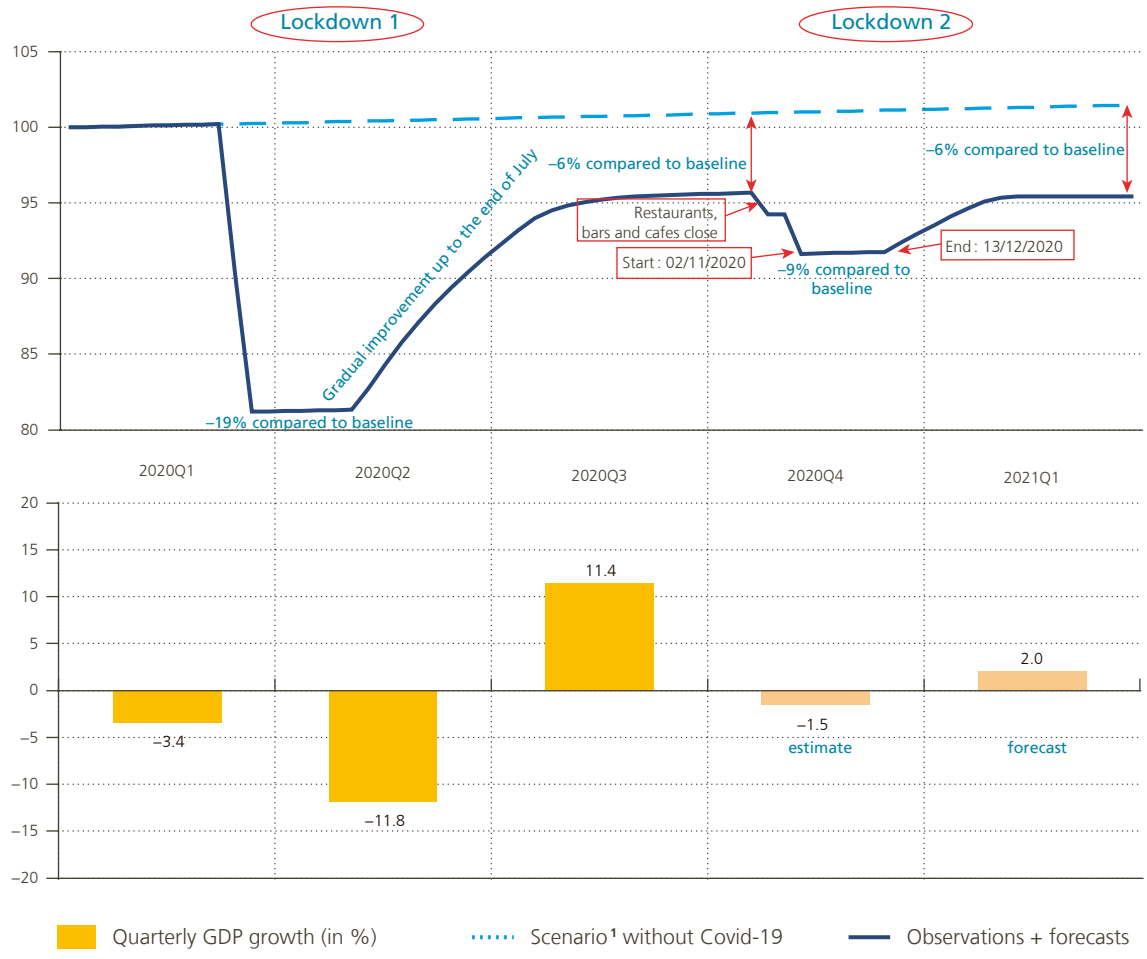
1 When comparing with the end-2019 level, the gap amounts to 5 %. However, when comparing with a no-COVID scenario, largely corresponding to the NBB's Autumn 2019 projections, the gap amounts to 6 %.

2 For more details on the results of the ERMG survey, please refer to the various press releases issued via a dedicated page on the website of the National Bank of Belgium as of 3 April.

Chart 1

The second lockdown pushes down economic output again, but the direct impact is more limited this time

(index, end of 2019 = 100, unless otherwise mentioned)



Sources : NAI, NBB.

1 This corresponds to the growth profile projected in the NBB's Autumn 2019 projections, but the figures have been updated with statistics until end-2019.

manufacturing industry have mostly remained fully operational this time, which was not the case in the spring. Finally, businesses seem to have been somewhat better prepared than in the spring to offset some of the losses of the closure of brick-and-mortar shops via e-commerce, take-away concepts and distance sales. All in all, it is estimated that the economy fell back to a level that is close to 10 % below the no-COVID-19 baseline during the second lockdown. This compares with a loss of close to 20 % in certain weeks in the spring.[1]

At the cut-off date for these projections, it was not clear how long this second lockdown would last. The measures were in principle valid until 13 December and in the NBB projections it was assumed that they would be discontinued then. This means that the economy would gradually recover from mid-December onwards as bars, restaurants and all shops open up again (albeit with social distancing measures and, hence, capacity

1 This estimate is calibrated on the basis of the ERMG surveys from that time but taking into account the quarterly statistics published by the NAI since then.

restrictions still firmly in place). In reality, shops reopened sooner, while bars and restaurants, but also various other businesses such as cinemas, as well as non-medical contact professions, will remain closed for longer. This element and the other risks to the projections are discussed in section 8.

Against this background, real GDP is currently estimated to drop again by 1.5 % on a quarterly basis in the last three months of the year. In annual terms, GDP posts a 6.7 % drop in 2020. This is clearly lower than the initial estimates, including the Bank's, as the impact of the better-than-expected outcome for the first half of the year is more important for the annual growth rate than the impact of the second lockdown in the final quarter. The latter will mostly weigh on the annual growth for 2021 as the starting point at the end of 2020 is lower.

In the first quarter of 2021, economic output should rebound by 2 % on a quarterly basis, thereby returning rapidly to the level reached just before the second lockdown. At this point, the remaining restrictions, such as those for arts, recreation and events or, more generally, the required social distancing, will continue to weigh on activity.

The economy should recover further once the availability of an effective medical solution leads to the gradual relaxation of these remaining restrictions. Therefore, in the current baseline scenario, the economy should decelerate in the second quarter of next year, but growth rates should pick up again from mid-2021 onwards before normalising in the outer quarters of the projection period. In annual terms, real GDP is projected to grow by 3.5 % and 3.1 % respectively in 2021 and 2022. By the end of 2022, economic output should have caught up with its pre-crisis level, after which growth rates are expected to moderate and return to their pre-crisis average as well, which leads to an annual growth of 2.3 % in 2023. The latter is still above potential, but this is due to the carry-over effect from the still higher quarterly growth rates in the course of 2022.

It is important to note that, even if output has reached its pre-crisis level again by 2022, a gap of about 3 % remains when compared with the output level that could have been reached without the COVID-19 crisis. This reflects the persistent scarring due to the historically deep crisis, which has damaged the Belgian production

Table 3

GDP and main expenditure categories

(seasonally adjusted volume data ; percentage changes compared to the previous year, unless otherwise stated)

	2018	2019	2020 e	2021 e	2022 e	2023 e
Household and NPI final consumption expenditure	1.9	1.5	–8.6	6.6	4.1	2.2
General government final consumption expenditure	1.2	1.7	0.0	4.3	0.4	1.3
Gross fixed capital formation	3.4	3.4	–12.1	2.1	5.8	5.1
General government	11.1	1.2	–2.6	13.2	1.1	8.7
Housing	1.5	5.2	–9.9	5.2	2.6	1.5
Businesses	2.8	3.2	–14.4	–1.0	7.9	5.6
p.m. Domestic expenditure excluding the change in inventories [1]	*2.0*	*2.0*	*–7.4*	*4.9*	*3.5*	*2.6*
Change in inventories [1]	0.3	–0.4	0.2	–0.4	0.0	0.0
Net exports of goods and services [1]	–0.5	0.2	0.5	–1.0	–0.4	–0.4
Exports of goods and services	0.6	1.0	–5.3	6.3	3.8	2.8
Imports of goods and services	1.3	0.8	–5.9	7.6	4.3	3.2
Gross domestic product	1.8	1.7	–6.7	3.5	3.1	2.3

Sources : NAI, NBB.

1 Contribution to the change in GDP compared to the previous year, percentage points.

capacity via increased bankruptcies and a rise in (structural) unemployment. The estimate of persistent scarring (measured at end-2022) has been revised down somewhat compared to the June 2020 projections, which is mostly due to the smaller initial impact, but should also be seen against the background of massive additional policy measures.

4. Belgian private consumption picks up quite quickly, while business investment takes longer to recover

During the first lockdown phase, which was spread (unevenly) over the first and second quarters of the year, all domestic demand components were negatively affected, with business investment posting the strongest percentage decline. According to the current statistics from the NAI, the rebound in the third quarter was largely driven by household spending, both on the consumption and the investment side.

The swift recovery in household consumption, as witnessed in the third quarter, did not come as a surprise and had been largely anticipated in the NBB's June 2020 projections. During the first lockdown, consumption possibilities had been strongly curtailed and household saving spiked accordingly as, on average, the impact on household disposable income remained limited thanks to the automatic stabilisers and the massive government support measures. The savings ratio shot up to 26.6 % of disposable income, according to the quarterly sectoral accounts for the second quarter of 2020. When the economy was gradually reopened, pent-up demand fuelled private consumption. This pattern should essentially be repeated in the context of the second lockdown, with household consumption taking another hit in the final quarter of 2020 but strongly recovering afterwards.

In annual terms, purchasing power per person declines only slightly in 2020. As market incomes recover, it should grow by close to 4 % in cumulative terms over the 2021-2023 period with income growth initially held back by the unwinding of the crisis support measures. In addition, the household saving ratio is projected to normalise and fall back to somewhat more than 14 % by 2023. This is still slightly higher than the pre-crisis level as the importance of the COVID-19 recession is likely to have a small persistent impact on precautionary saving.

All in all, private consumption should grow strongly throughout 2021, in addition to the post-lockdown recovery at the start of the year, before gradually returning to more normal growth levels towards the end of the projection period. In this connection, the findings of a June 2020 survey by the Bank suggest that, even when physical shopping outlets are open, consumption is mostly held back by the fear of being infected or by the imposition caused by the health and safety requirements when shopping. Hence, the implementation of an effective medical solution should further boost private consumption next year. By early-2022 household spending should have already reached its pre-crisis level again, despite the new setback in the context of the second COVID-19 wave.

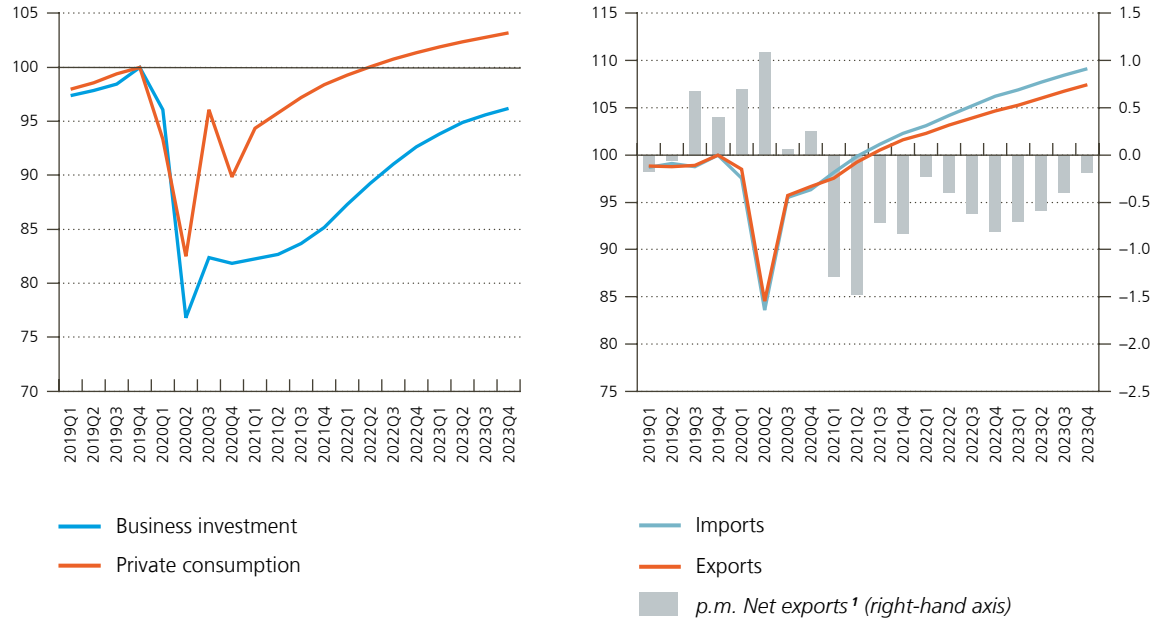
Business investment was cut by nearly a quarter in the first half of the year and only a small part of that loss was offset in the third quarter. Companies have to deal with a sudden and, in modern times, unprecedented shock that affects both the supply and the demand side. In addition, the COVID-19 shock erodes their operating surpluses and profit margins and the uncertainty about the recovery of demand remains very high (with a possible no-deal Brexit adding to that uncertainty). Hence, firms are massively pushing back or even cancelling their investment plans. As shown by the latest ERMG surveys, the downward impact on investment should last well into 2021. Accordingly, the current projections see business investment recovering only quite gradually and remaining below the pre-crisis level even at the end of the projection horizon.

The very high level of uncertainty but also certain physical constraints during the first lockdown phase (that affected the construction industry) pushed residential investment down by 20 % in the first half of the year but the summer months saw a firm rebound of nearly 16 % on a quarterly basis. As the construction industry

Chart 2

Private consumption recovers more easily than business investment and net exports weigh on growth

(index, 2019Q4 = 100, unless otherwise mentioned)



Sources: NAI, NBB.

1 Contribution to the change in GDP compared to the previous year, in percentage points.

remains operational during the second lockdown, residential investment is expected to take only a minor hit in the last quarter of the year. Since the fundamentals remain healthy, with historically low mortgage rates in particular, housing investment should rebound strongly in 2021 and post relatively solid growth afterwards.

Export growth is projected to largely mirror the trend in export market growth, dropping markedly in the second quarter of this year, but gradually picking up thereafter. Belgian exporters are set to see some decline in their market shares throughout the entire projection period, reflecting longer-term competitiveness trends. Imports show a pattern that is similar to that of exports, although they recover somewhat more strongly. This can be traced back to the swift recovery of household consumption, which is partly imported and possibly even to a higher degree than in the past, given the growing popularity of e-commerce (from foreign firms in particular). In addition, the expected recovery of global tourism should be a drag on net exports as Belgians typically spend substantially more on tourism abroad than foreign tourists spend in Belgium. As a result, net exports reduce GDP growth slightly over the following years, by an annual average of close to 0.6 pp.

Turning to public expenditure, public consumption posts zero growth in 2020. This reflects, on the one hand, the decline in spending caused by the postponement of many regular (non-COVID-19 related) medical procedures in order to free up capacity for COVID-19-patients in the hospitals, and, on the other hand, higher government support for coronavirus-related spending in the healthcare system. The healthcare budget for 2021 has been increased, boosting public consumption growth, before rates revert to normal as of 2022. As the interruptions in the construction industry have also affected public works, government investment also shrinks in 2020, but it is projected to rebound sharply next year as a reflection of government recovery plans. Public investment growth in 2022 should remain fairly limited in the run up to 2023, the year in which the usual local election cycle boosts investment.

5. The COVID-19 impact on the labour market remains all in all quite "limited"

The Belgian labour market has expanded continuously since mid-2013 and the unemployment rate reached a historical low in 2019 at 5.4 %. While the labour market was already expected to lose some traction, the COVID-19 containment measures put a sudden stop to this favourable trend and, in the first half of the year, employment fell by close to 1 % compared to the end of 2019.

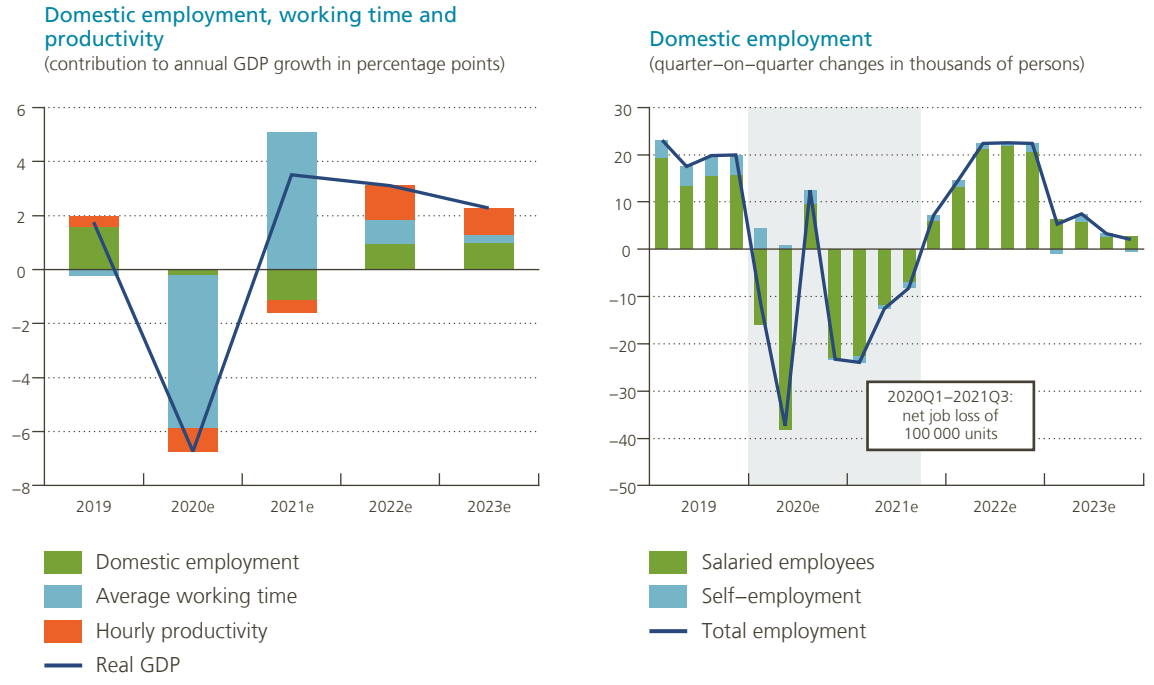
However, in response to the crisis, the government has put in place measures to limit permanent job losses in the short term so that workers can be reintegrated once activity picks up again. In this connection, the temporary unemployment scheme for employees and the bridging rights system for the self-employed were broadened and reinforced. These systems have cushioned the initial shock on employment.

At the peak of the first COVID-19 wave, in April, over 1 million employees benefited from temporary unemployment benefits, albeit on a part-time basis for most; while about half of the self-employed (about 400 000 people) applied for a bridging right. During the summer, the requests for this financial support declined, although about 10 % of private salaried employment remained affected by temporary unemployment. The second lockdown should again have led, albeit to a lesser extent than in the spring, to a more intensive use of such financial support schemes.

The drop in activity in the first half of the year was mainly reflected by a strong fall in average hours worked and, due to labour-hoarding, a decline in labour productivity. In fact, the first statistics suggest that employment

Chart 3

From the first quarter of 2020 until the third quarter of 2021, about 100 000 jobs should be lost



Sources: NAI, NBB.

was already on the rise again in the third quarter of 2020. Remarkably, the number of self-employed has even continued to grow throughout the first three quarters of 2020. However, employment should decline again in the final quarter of 2020 and job losses are likely to continue well into next year as the temporary support systems come to an end. Only by the final quarter of 2021 will jobs start to be created in net terms again.

The annual averages of employment growth are also determined by carry-over effects (in particular from the strong employment growth in the course of 2019), but from the first quarter of 2020 until the third quarter of 2021, about 100 000 jobs should be lost. This is somewhat lower than firms' estimates in the most recent ERMG survey (November 2020) that point to some 140 000 job losses in the private sector by end-2021 but those responses may be slightly too pessimistic (given the recent boost to confidence from the announced availability of a vaccine in early-2021) and may not yet reflect the surprising uptick in employment in the third quarter of 2020. Given the size of the shock on GDP, a decline of 100 000 jobs should be considered as quite moderate and points to the resilience of the Belgian labour market in bad times.

The increase of the number of unemployed job-seekers will also be slower and more limited than initially expected. However, in 2020 in particular, this also reflects a rising number of discouraged workers (mostly without unemployment benefits) dropping out of or not entering the labour force during the first lockdown as a result of few job opportunities, restrictions on physical movements and associated health risks. In 2021, the increase in the number of job-seekers should better reflect the expected job destructions and the harmonised unemployment rate should rise to 7 %. While employment will outpace the labour force as of 2022, the minor decline in the number of unemployed job-seekers should still leave the unemployment rate close to 7 % up to the end of the projection period. Despite the much larger shock on GDP, the projected increase in the unemployment rate is comparable to that seen in the 2008-2010 period, due to the Global Financial Crisis.

Table 4

Labour supply and demand

(seasonally adjusted data; change in thousands of persons, unless otherwise stated)

	2018	2019	2020 e	2021 e	2022 e	2023 e
Total population	55	58	56	49	47	45
Working age population [1]	13	17	14	8	6	4
Labour force	40	58	19	30	20	27
Domestic employment	70	76	–10	–56	46	47
Employees	56	61	–23	–55	44	44
Self-employed	13	14	13	–1	3	2
Unemployed job-seekers	–30	–19	29	86	–26	–20
p.m. Harmonised unemployment rate [2, 3]	*6.0*	*5.4*	*5.6*	*7.4*	*7.1*	*6.7*
Harmonised employment rate [2, 4]	*69.7*	*70.5*	*69.8*	*68.9*	*69.5*	*70.1*

Sources: FPB, NAI, NEO, Statbel, NBB.
1 Population aged 15-64 years.
2 On the basis of data from the labour force survey.
3 Job-seekers in % of the labour force aged 15-64 years.
4 Persons in work in % of the total population of working age (20-64 years).

6. Relatively strong labour cost growth is mainly due to price indexation

Labour cost developments in both 2020 and 2021 are strongly affected by specific temporary factors related to the COVID-19 crisis. Unit labour cost growth is particularly high in 2020. This reflects the normal decline in labour productivity in crisis periods due to labour hoarding but also the specific impact of the temporary unemployment scheme. While the latter is financed through government transfers and, hence, does not directly affect labour costs, there are important composition effects due to the over-representation of low-wage earners in this scheme. Low-wage earners tend to be affected more by temporary unemployment (as shown in the monitoring reports of the working group on the social impact of COVID-19[1]), mostly because they work relatively more often in the most heavily affected industries such as accommodation, events and non-food retail. This implies that the average wage of those workers that are not on temporary unemployment and are paid by the firms increases. This pushes up average wage costs in 2020 (technically via higher wage drift) but partly unwinds in 2021, as low-wage earners switch from temporary unemployment to regular employment. In addition, the crisis-related job losses lead to larger severance payments that also represent costs for firms and are recorded as social contributions. The same applies when employers top up temporary unemployment benefits in line with industry- or company-specific agreements. Finally, in certain industries (including federal health care) employees have received compensation or bonuses during the crisis.

The crisis-related increase in labour costs is, however, partially offset by the impact of several temporary government measures which take the form of wage subsidies. These include the partial exemption of the transfer of withholding tax on earned income for employers in severely hit sectors to stimulate the return of the workforce from temporary unemployment, various government subsidies (related to the payment of end-of-year bonuses in the hospitality sector and the specific bonuses for health care workers or targeted to service voucher companies), as well as the compensation of social contributions paid for employers forced to close during the second lockdown.

Turning to the underlying trends, hourly wage costs should post solid growth throughout the projection period. Yearly increases will exceed 2 % in the three following years. About 70 % of that increase can be traced back to the indexation mechanisms. As Belgian inflation rates are set to remain higher than in the euro area, this will also lead to relatively buoyant nominal wage developments.

Conventional wage growth should rise more moderately. As there is currently no information on the nationwide private-sector wage norms for the projection period, the technical assumption was made that the increase in negotiated wages, excluding the salary increases for health care workers, should be limited in 2021. The increase is expected to moderately accelerate over the remainder of the projection period. This should be broadly in line with the developments observed in the most recent period, despite the strong pick-up in employment, economic activity and productivity. On average, negotiated wages are projected to rise by 0.6 % per annum. The latter growth rate includes the significant pay rise for health care workers in federal and Walloon care facilities (that pushes up nationwide wage growth by a cumulative 0.5 % in the 2021-2022 period). However, this does not affect total wage costs, as it is fully offset by wage subsidies. It should also be stressed that a similar measure to increase wages in the Flemish care facilities could not be incorporated into these projections, as it was announced just at the cut-off date and the details were not yet sufficiently known.

As hourly labour productivity will recover gradually and rebound strongly in the outer years of the projection period, unit labour costs should increase more moderately than hourly labour costs. They are set to increase by 1.6 % per year in the 2021-2023 period.

1 Please refer to https://socialsecurity.belgium.be/nl/sociaal-beleid-mee-vorm-geven/sociale-impact-covid-19, available in Dutch or French.

Table 5

Price and cost indicators

(percentage changes compared to the previous year, unless otherwise stated)

	2018	2019	2020 e	2021 e	2022 e	2023 e
Private sector labour costs[1]:						
Labour costs per hour worked	1.5	2.3	3.3	2.2	1.9	2.3
of which:						
Conventional wages	0.4	0.7	0.5	0.5	0.8	0.6
Wage drift and other factors	0.2	–0.1	2.4	–0.4	0.1	0.1
Indexation	1.7	1.8	1.0	1.2	1.7	1.7
Social contributions	–0.8	0.0	0.3	0.5	–0.6	0.0
Wage subsidies	0.0	–0.1	–1.0	0.5	0.0	0.0
p.m. Labour costs per hour worked according to the national accounts[2]	*1.5*	*2.3*	*4.3*	*1.8*	*1.9*	*2.4*
Labour productivity[3]	0.3	0.6	–1.2	–0.5	1.4	0.9
Unit labour costs[1]	1.2	1.7	4.5	2.8	0.5	1.4
Total inflation (HICP)	2.3	1.2	0.4	1.7	1.9	1.9
Core inflation[4]	1.3	1.5	1.3	1.4	1.6	1.7
of which:						
Services	1.6	1.8	1.7	1.7	1.9	2.1
Non-energy industrial goods	0.8	1.0	0.7	0.9	1.1	1.1
Energy	8.9	–0.8	–11.2	0.9	1.6	1.1
Food	2.7	1.3	2.8	3.2	3.0	2.9
p.m. Inflation according to the national index (NCPI)	*2.1*	*1.4*	*0.8*	*1.4*	*1.7*	*1.8*
Health index[5]	1.8	1.5	1.0	1.4	1.7	1.7

Sources: Eurostat, FPS Employment, Labour and Social Dialogue, NAI, Statbel, NBB.

1 Labour costs are not shown here according to the national accounts concept but according to a broader concept that also includes reductions in contributions for target groups and wage subsidies. That concept gives a better idea of the true labour cost for firms.

2 Excluding wage subsidies and reductions in contributions for target groups.

3 Value added in volume per hour worked by employees and the self-employed.

4 Measured by the HICP excluding food and energy.

5 Measured by the national consumer price index excluding tobacco, alcoholic beverages and motor fuel.

The strong crisis-related increase in wage costs is partly offset by a decline in corporate margins. As wage costs moderate somewhat, profit margins will recover only partially. By 2023, they should be close to the long-run average which is below the pre-crisis level.

All in all, core inflation is projected to edge up gradually from 1.3 % to 1.7 % over the projection horizon. Services inflation should initially stabilise at 1.7 % and rise only slowly to just above 2 % by 2023. The pass-through of rising labour costs is moderated by the weak profit margin growth, as the COVID-19 crisis continues to depress demand in the first part of the projection period and certain services prices are assumed to remain

Chart 4

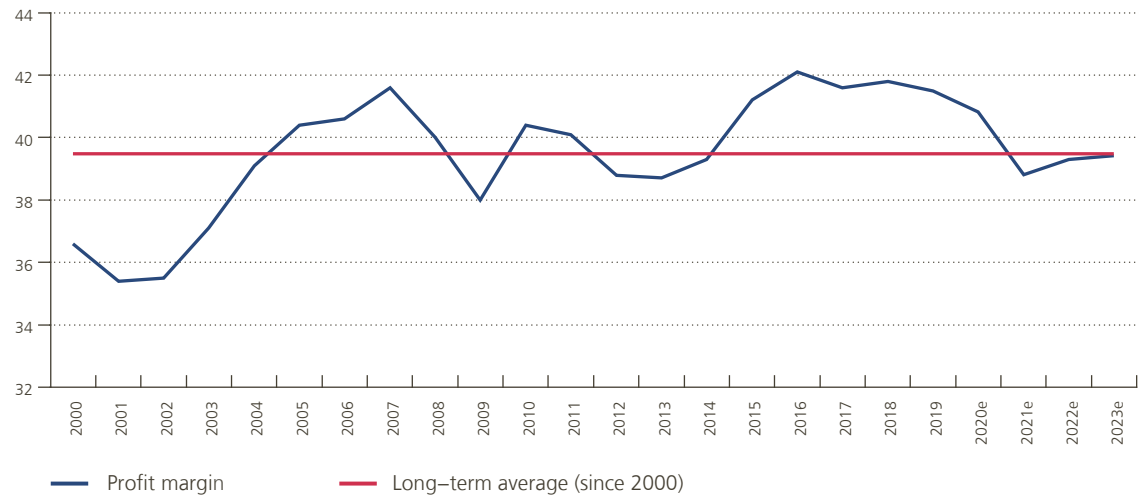
Lower energy prices bring down inflation in 2020 but core inflation rises gradually

Sources: Eurostat, NAI, NBB.

1 The chart is inspired by an article in the Bulletin of the Banque de France No. 225-(September/October-2019) by Diev, Kalantzis and Lalliard: "Why have strong wage dynamics not pushed up inflation in the euro area?". Margins are defined as GDP deflator growth minus unit labour cost growth. "Other" factors are mainly determined by changes in the terms of trade excluding energy and food, and by price differences between private consumption and other domestic demand components such as government consumption and investment. This term also comprises a statistical adjustment due to differences between the consumption deflator and the HICP inflation.

Chart 4 (next)

Profit rate of non–financial corporations
(in %, gross operating surplus divided by gross value added)



Sources: Eurostat, NAI, NBB.

constant when facilities are closed during a lockdown (in line with Eurostat recommendations). Inflation is somewhat more volatile for non-energy industrial goods: it drops to 0.7 % in 2020 but should then pick up gradually as the domestic and international economy, as well as international trade recover. Core inflation is clearly more resilient in Belgium than in the euro area as a whole, where it was close to zero in the final quarter of 2020. Through the indexation systems, this also pushes up wage growth in Belgium.

Due to the expected rise in excise duties on tobacco from January 2021, food inflation is expected to accelerate following an already strong hike in 2020, when both COVID-19 factors – temporary promotion ban in supermarkets and supply difficulties – as well as other factors – such as weather conditions and African swine fever – temporarily pushed it up. The strong hike in food prices and the bigger share of food in spending during the spring lockdown implies that total inflation would have been around 0.4 percentage point higher than the official measure in April and May if one adjusts consumption basket weights to better reflect actual spending patterns.[1]

Despite the resilience of core inflation and the uptick in food inflation, total inflation becomes very low in 2020, mainly as a result of the past decline in energy prices (primarily oil-derived products, but gas and electricity also contributed negatively). Total inflation is expected to shoot up again in 2021 and developments in headline inflation will be more in line with those in core inflation, as energy price growth should return to positive territory. In this respect, while the price of a barrel of Brent crude oil should be as low as $ 42 on average in 2020, it should slightly rise over the projection horizon (by around 4 % on average per year), according to the Eurosystem assumptions.

1 For a further analysis, see Jonckheere, J. and H. Zimmer (2020), "Consumer prices in light of the COVID-19 crisis", NBB, *Economic Review*, December.

The national consumer price index (NCPI) is used to calculate the health index (see above), which excludes tobacco, alcoholic beverages and motor fuels, and serves as a reference for price indexation of wages and replacement incomes. As electricity, heating oil and gas are taken into account in the health index, its growth rate only comes down to 1 % in 2020 and picks up to 1.7 % in 2022 and 2023. The threshold index for public wages and social benefits is next set to be exceeded in July 2021.

7. The general government deficit shoots up and is expected to come down only gradually in the next few years

In 2020, the general government deficit is estimated to shoot up, reaching 10.6 % of GDP, the highest deficit recorded since the mid-1980s. On the revenue side, fiscal and parafiscal revenues decline in line with economic activity. Primary expenditure is rising relative to GDP, and is boosted by automatic and discretionary government support measures that help absorb the COVID-19 economic shock.

While market incomes of both companies and households are very seriously affected by the economic crisis, the government sector partly offsets those losses. This cushions the blow for households and companies that see their after-tax disposable income decline to a lesser extent than their market incomes. In addition, indirect taxes such as VAT and excise duties also shrink due to the declining tax bases such as private consumption. Income losses by households are further offset by temporary replacement incomes that help preserve employment and keep the self-employed afloat. So, the government budget has clearly absorbed most of the income losses generated by the coronavirus crisis. Furthermore, the government has taken discretionary measures to shore up businesses, support the most vulnerable, and manage the health crisis. These stimulus measures and temporary replacement incomes weigh on the budget balance to the tune of roughly € 22 billion.

Since the health crisis is expected to persist for at least part of next year, and economic recovery will only be gradual, most stimulus measures will continue to burden public finances in 2021, albeit at a lower cost, and the negative impact via automatic stabilisers will only gradually unwind. At the same time, regional and federal governments are planning recovery and resilience measures to boost the economy and its potential, primarily through government investment and transfers to firms. The projections are based on the assumption that parts of these plans will be financed via grants from the Resilience and Recovery Facility, an EU instrument that should

Table 6

General government accounts

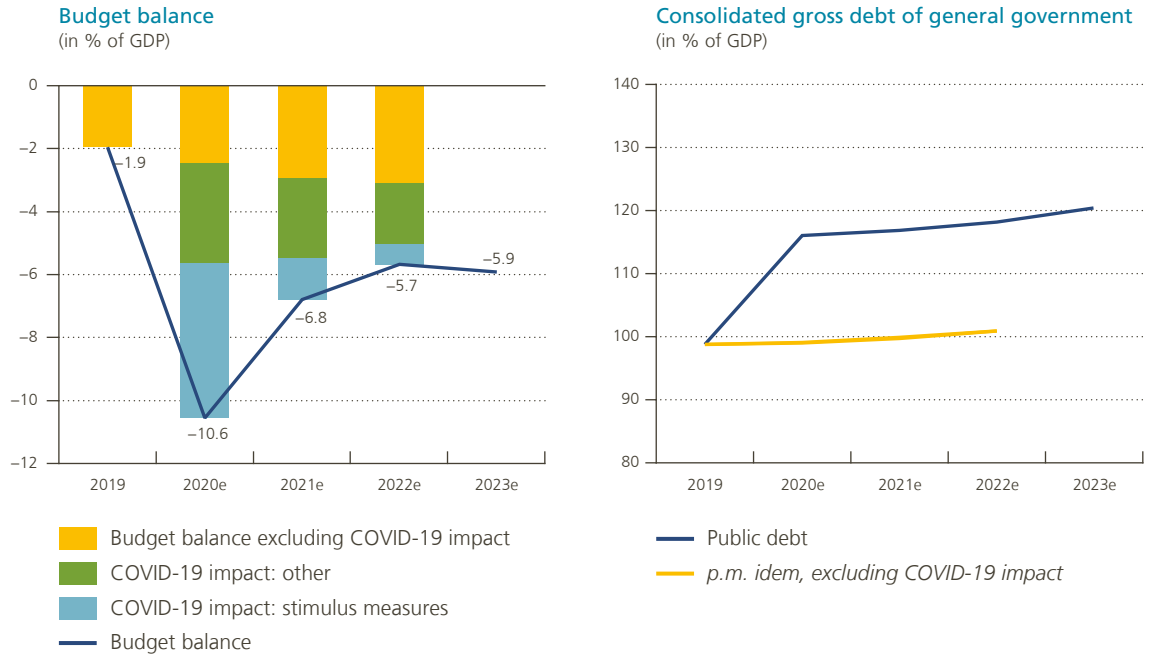
(in % of GDP)

	2019	2020 e	2021 e	2022 e	2023 e
General government					
Revenue	50.1	50.5	51.4	50.9	50.7
of which: fiscal and parafiscal revenue	43.0	43.1	43.8	43.3	43.2
Primary expenditure	50.1	59.1	56.4	55.0	55.1
Primary balance	0.0	–8.6	–5.0	–4.1	–4.4
Interest charges	2.0	2.0	1.8	1.6	1.5
Financing requirement (–) or capacity	–1.9	–10.6	–6.8	–5.7	–5.9

Sources: NAI, NBB.

Chart 5

Public finances are seriously hit by the COVID-19 pandemic



Sources: NAI, NBB.

help Member States as they emerge from the crisis. As a result of the persistence of the health crisis and its impact on economic activity, the 2021 deficit forecast remains high, at 6.8 % of GDP.

In 2022 and 2023, the budgetary situation is expected to improve, as the economy slowly recovers and temporary support measures unwind. The budget deficit is expected to persist at just below 6 % of GDP, though. This mostly reflects the fact that the coronavirus crisis has a lasting impact on GDP within the projection period. Structural increases in pensions and health-care-related expenditure further impede budgetary consolidation. Interest payments, for their part, contribute to the improvement of public finances over the projection horizon on the back of expected interest rates close to zero, despite higher borrowing requirements.

The government debt ratio is estimated to shoot up dramatically this year, by almost one-fifth. This reflects not only the large government deficit but also the deep recession, as the debt ratio is expressed as a share of GDP. In the remaining years of the projection period, the debt ratio is expected to remain on an upward path. High primary deficits, of more than 4 % even by the end of the projection horizon, more than offset the favourable impact from growth and historically low interest rates. Therefore, bringing public finances back onto a sustainable path in the medium term requires structural measures to push up economic growth and consolidate public finances.

8. The baseline projections come with important downside and upside risks

Clearly, the uncertainty surrounding the baseline economic projections that are described in this article is still much larger than usual. As suggested by the Economic Policy Uncertainty indicator, the uncertainty level has declined somewhat compared to the peak observed in the spring, but it is still comparable to the level that prevailed at the height of the Global Financial Crisis in 2008-2009. In addition, the balance of risks is difficult to assess, as it is intricately linked to the further development of the pandemic.

First, there is uncertainty regarding the short term. On the basis of the information available at the cut-off date of the projections, it was assumed that the current lockdown measures would have ended on 13 December. In reality, non-essential shops were allowed to open on 2 December already (albeit under certain restrictions), while bars and restaurants will remain closed for longer. On balance, this may lead to upward risks for private consumption in December. By consequence, the NBB's Business Cycle Monitor for 2020Q4, which has a later cut-off date and was already able to incorporate the new information, shows a slightly less severe fall in GDP. At the same time, a new flare-up of COVID-19 infections early next year could lead to a much longer closure of bars and restaurant or, especially, additional containment measures, that would depress growth in 2021.

In the medium term, a quicker availability and implementation of an effective medical solution than what is assumed in these projections could lead to a faster dissipation of the remaining uncertainty and boost both private consumption and investment. This could be the case if the current optimism regarding the start of the vaccination campaigns is confirmed. Alternatively, unexpected setbacks in the implementation of such a medical solution are likely to increase uncertainty again and the negative impact on the real economy could then also be amplified by adverse financial developments.

The behaviour of economic agents in the current conditions constitutes a second vector of uncertainty. In this connection, the projected evolution of the household saving ratio would appear to be key and comes with

Chart 6

Economic Policy Uncertainty in Belgium

(newspaper-based uncertainty indicator; higher values represent greater economic policy uncertainty)

Source: Algaba, A., Borms, S., Boudt, K. & Van Pelt, J. (2020). The Economic Policy Uncertainty index for Flanders, Wallonia and Belgium. Research note. doi: 10.2139/ssrn.3580000.

downside and upside risks. Given the unprecedented nature of the economic shock, precautionary saving could remain higher for longer. At the same time, a reassuring medical scenario such as in the baseline projections could also push households to spend (part of) the accumulated wealth due to extra saving in 2020. This would imply that the saving ratio could temporarily drop below its pre-crisis level in the projection period, which in turn would boost private consumption and growth. Similarly, the recovery of corporate investment depends on the development of business confidence, which is very difficult to predict.

Finally, the baseline projections take account of the policy environment that was known at the cut-off date. Measures that were or will be announced after that date are not incorporated. The package that was announced in late November by the Flemish government to increase salaries and improve working conditions in Flemish care facilities could not be included in the projections, for example. A specific element of uncertainty pertains to the Brexit scenario : if a trade deal is still agreed on in December, exports in 2021 are likely to be somewhat higher than in the current baseline scenario. More generally, in the near term, both fiscal and monetary support could be more accommodative if the current COVID-19 wave dents the growth outlook. In the longer term, the unsustainable budget position will have to be addressed, which may require consolidation measures in the second part of the projection period. Depending on the specific measures that will be taken, the growth and budget outlook may be quite different.

Annex

Projections for the Belgian economy: summary of the main results

(percentage changes compared to the previous year, unless otherwise stated)

	2018	2019	2020 e	2021 e	2022 e	2023 e
Growth (calendar adjusted data)						
Real GDP	1.8	1.7	–6.7	3.5	3.1	2.3
Contributions to growth:						
Domestic expenditure, excluding change in inventories	2.0	2.0	–7.4	4.9	3.5	2.6
Net exports of goods and services	–0.5	0.2	0.5	–1.0	–0.4	–0.4
Change in inventories	0.3	–0.4	0.2	–0.4	0.0	0.0
Prices and costs						
Harmonised index of consumer prices	2.3	1.2	0.4	1.7	1.9	1.9
Health index	1.8	1.5	1.0	1.4	1.7	1.7
GDP deflator	1.6	1.7	0.6	1.6	1.5	1.5
Terms of trade	–0.9	0.8	0.4	0.1	–0.1	–0.1
Unit labour costs in the private sector [1]	1.2	1.7	4.5	2.8	0.5	1.4
Hourly labour costs in the private sector [1]	1.5	2.3	3.3	2.2	1.9	2.3
Hourly productivity in the private sector	0.3	0.6	–1.2	–0.5	1.4	0.9
Labour market						
Domestic employment (annual average change in thousands of persons)	69.7	75.6	–10.0	–56.2	46.4	46.7
Total volume of labour [2]	1.6	1.3	–5.8	3.9	1.8	1.3
Harmonised unemployment rate (in % of the labour force aged 15 years and over)	6.0	5.4	5.6	7.4	7.1	6.7
Incomes						
Real disposable income of individuals	1.1	3.1	0.1	1.4	1.4	2.2
Savings ratio of individuals (in % of disposable income)	11.6	13.0	20.7	16.6	14.4	14.4
Public finances						
Primary balance (in % of GDP)	1.3	0.0	–8.6	–5.0	–4.1	–4.4
Budget balance (in % of GDP)	–0.8	–1.9	–10.6	–6.8	–5.7	–5.9
Public debt (in % of GDP)	99.8	98.1	116.1	116.9	118.2	120.4
Current account (according to the balance of payments, in % of GDP)	–0.8	0.3	0.5	–0.4	–0.8	–1.2

Sources: EC, NAI, Statbel, NBB.

1 Including wage subsidies (mainly reductions in payroll tax) and targeted reductions in social contributions.

2 Total number of hours worked in the economy.

Belgium's innovative capacity seen through the lens of patent data

S. Cheliout*

Introduction

Largely documented, the slowdown of productivity growth observed over the last decades has been more pronounced in Europe than in the United States. Belgium, in particular, has precariously exhibited some of the lowest gains[1]. This happened despite the emergence of new technological waves, like digitalisation. These new technologies came along with their share of promise to revive the lethargic trend in productivity, feeding into what is commonly referred to as the productivity "puzzle" or "paradox". Amongst the various tracks investigated, a lack of technological diffusion, along with increasingly complex processes faced by firms to master new cross-cutting technologies and business models, might have contributed to explaining the widening productivity gap between firms operating at the efficiency frontier and the technological laggards. Some empirical studies[2] also suggest that the emergence of breakthrough innovations has been accompanied by the rise of global champions and greater industry concentration, perpetuating the growing productivity divide.

Empirical work on innovation performance frequently relies on patent data: patents are a mean of protecting inventions – either new products or new processes – and they are typically used to proxy the innovative capacity of a country. Although the relationship is not straightforward, a positive correlation between patent counts and other indicators related to innovative and economic performance has been put forward in the literature. Yet, a broader generalisation of such effects of patenting is difficult to make, as the effectiveness of patents seems to vary considerably by industry sector and technological field[3]. Patents essentially play a dual role of providing incentives to innovate, thanks to the protection they confer on inventions, and of facilitating the diffusion of technology, since they are legal titles that can be traded, in turn improving the allocation of technology resources in the economy[4]. But before an invention even becomes an innovation, in addition to the initial efforts made at the upstream level of research and development (R&D), entrepreneurial efforts are further required to develop, manufacture and market the new product or process invented. On that account, patents provide information on the output or downstream side of innovation.

The documents filed for each patent application provide a large amount of information, from its technological description and sketch of the invention to the geographical location of the researchers or entities involved. The latter makes it possible to identify and distinguish the owners of the patent – called 'applicants' – from its inventors.

* The author is grateful to and warmly thanks Prof. Bruno Van Pottelsberghe, as well as Emmanuel Dhyne, Carine Swartenbroekx and Jan De Mulder, for providing their constructive comments and suggestions.

1 See NBB (2020) and National Productivity Board (2019).

2 See IMF (2019).

3 See OECD (2004) and OECD (2009).

4 See OECD (2009).

This rich and complex information on patents is a major gateway to analysing the ability of research entities – private firms, universities, laboratories, etc. – involved in yielding inventions and new technologies, whether they originally produce them, or rather collaborate with them.

That said, patenting is not compulsory and therefore not all inventions are patented. Companies may prefer secrecy agreements or rely on other types of mechanisms to gain market dominance. Others may choose to go through contractual agreements to be able to buy the right to use a specific technology, without necessarily contributing to its production : licensing and other similar types of arrangements between firms offers this extra dimension of technology cross-fertilisation between firms or other entities involved in research and innovation.

This article aims at providing some descriptive insight into the following questions : how does the innovative capacity of Belgium compare with its European peers ? Does the fact that it is a small open economy come with its perks, namely the benefits from the technology flows induced by joining the international research collaboration networks ? Or rather, does this strategy mean that the innovative capacity of the country is more vulnerable ? New emerging technologies – green tech, artificial intelligence (AI), digitalisation – offer tremendous opportunities, not least in view of the productivity gains they could bring. Gauging whether Belgium is well-positioned in those fields is of great importance for potential (future) growth.

1. The patent filing landscape

Before analysing the patterns of patenting that characterise Belgium, this first section takes a look at the main trends observed in similar geographical markets. Further described in Annex 1, patent data are a rich source of information. At the same time, they are complex, not least because of the large range of possible patent protections and routes (national, regional, international), but also since they can be largely influenced by the laws and procedures of the national patenting offices. Irrespective of innovative strategies engaged by companies or other research entities, the different standards imposed by patent offices may merely result in varying propensities to fill an application for a patent. In addition, the timeliness of data availability may also diverge depending on the patent office considered. Ultimately this will be reflected into the patent counts. Therefore, it is necessary to handle such data cautiously and their interpretation must take into account these constraints and specificities.

For this reason, and to start with, setting the stage for Belgium requires a careful comparison of patent-based indicators. A common statistical approach to analyse cross-country indicators of patents is to gather information on filings (or eventually grants) from a particular patent office [1]. In this section, we focus on patent applications filed at the European Patent Office (EPO). This section seeks to address the following issues : which countries are most active in patenting ? How does Belgium compare with other major economies ? Which technologies are most patented and developed the most quickly ?

1.1 Setting the stage in the European market

According to the OECD definition [2], patents are a legal instrument endowing their owner with a set of exclusive rights over an invention, a product or process that is new, and/or involves an inventive step, susceptible of

1 As explained in the caveat on patents' measurement issues further, a single office of reference is also usually preferred because differences in patent regulations and changes in patent laws over the years make it difficult to compare counts across countries and to analyze trends over time. Patent counts across different offices are usually not directly comparable to allow for a correct assessment of countries' performances.

2 OECD (2009).

industrial application. Such protection gives the owner the right to exclude others from making, using, selling, or importing the patented invention during the term of the patent, valid for a maximum of 20 years after the date of application. To do that, national, regional and international procedures are possible avenues for applicants to register their patents. Those administrative procedures are very diverse and will be chosen by the applicant depending on the specific needs and commercial strategy sought[1].

The EPO offers legal protection of inventions in the 28 EU countries[2] and in 10 other associated countries. We consider direct applications to the EPO as well as the international patent applications that entered the European phase during the reference period (Euro-PCT[3] applications) from all countries, as a proxy of the overall patenting activity in the European market: this broadly reflects the interest and appeal of research entities worldwide to protect their innovations on the European market.

Over the three most recent years for which data are available (2017-2019)[4], the aggregate number of patents applied for with the EPO increased steadily, by around 4.5 % a year on average. This pace is slightly above the growth recorded during the recovery phase of the last euro area sovereign debt crisis. Since this crisis, Europe has therefore reaffirmed itself as being an attractive and strategic place for innovation.

Looking at the country of origin of the patent applicants, nearly half of them come from European countries. This naturally reflects a so-called 'home bias' (see our caveat on measurement issues below) where European entities are more inclined to protect the new product developed in Europe than non-Europeans entities. But besides this strong European foothold, an international presence also remains firmly grounded in the European market, especially applications from the United States which accounts for one-quarter of all patent applications to the EPO, followed by Japan (14 %). That said, some of these main players have gradually lost market power at the expense of other international – especially Asian – countries. The latter have penetrated the European market to strategically protect their innovations there. Korea, and especially China, have posted well-above-average growth of patents applications to the EPO, with the steepest acceleration in the years after 2000. As a result, while China only ranked the 22nd biggest applicant in 2000, it jumped to the 5th leading position in 2019, as evidence of the country's technology catch-up.

As far as European applicants are concerned, Germany leads the pack, accounting for nearly 40 % on average of all EU28 applicants, well ahead of the second runner France (around 7 % of all EPO applications), followed by the United Kingdom, the Netherlands and Italy (around 3 % each). In Germany's case, it is worth noting that a legal provision increases the propensity to patent for German firms[5]: but even despite this, the country is the real power house among European countries in terms of patenting. The breakdown of European applications by type of entity in 2019 shows that nearly two-thirds were initiated by large enterprises (72 %) while only 18 % were filed by SMEs and individual inventors, and the remaining 10 % by public research entities[6].

1 See Annex 1 for a detailed description of the patenting process.

2 In this article, we considered the aggregate of the EU28 when the years considered preceded the Brexit (2017).

3 PCT stands for Patent Cooperation Treaty (see Annex 1).

4 In what follows, the most recent data presented come from the official publications of the EPO. The reason for it is that one major drawback from pour internal research work based on extractions from the PATSTAT database is their timeliness issue: due to the 18 months publication delay, official EPO data estimations for the most recent years (2017-2019) cannot be fully replicated with the information that is made publicly available in the PATSTAT database. The EPO official figures published for those most recent years are calculated internally (through extrapolations) at the EPO and cannot be replicated for external users.

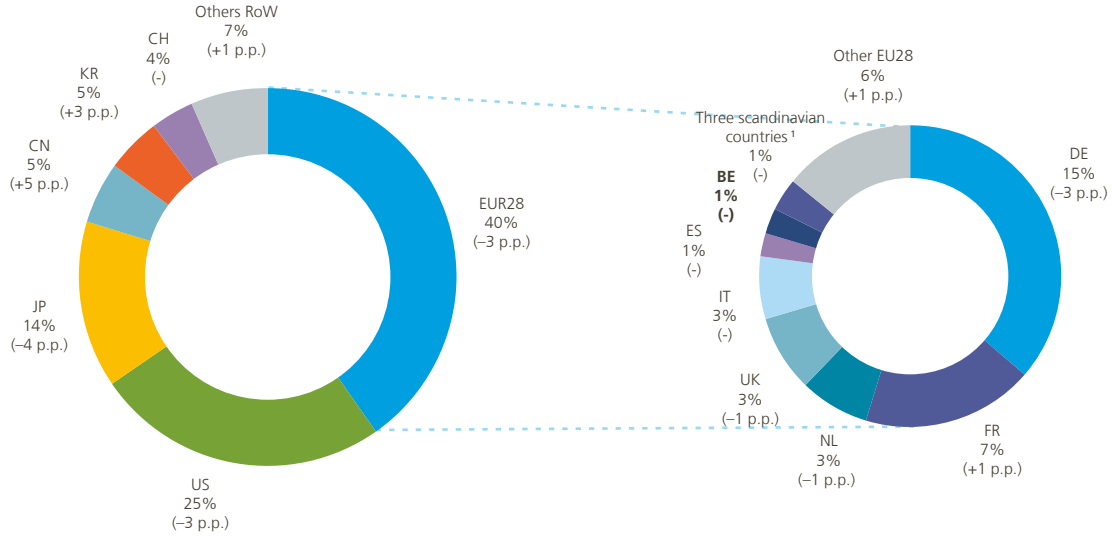
5 According to the German Employee Inventions Act, any invention made by an employee must be immediately reported to his/her employer and the right over the invention is thus transferred to the employer who has to apply for a corresponding patent. Changes introduced to the regulation stipulates that if employers do not explicitly waive their claim to the invention within four months of receiving the report, the invention and all the rights and obligations associated with it belong to the employer.

6 The definition used by the EPO includes different sub-entities including universities. Their specific role will be further addressed in a subsequent section.

Chart 1

Country of origin of patent application at the EPO from all world economies and the EU28

(in % of direct and Euro-PCT applications, average for 2015-2016, figures in brackets are in p.p. and compared to the average in 2000-2004)



Source: EPO (PATSTAT).

1 Denmark, Finland, Sweden.

1.2 How is Belgium ranked?

Over the last ten years, Belgium has produced around 2 000 patents a year: according to the EPO, 2 423 patents were filed with its office in 2019[1], an increase of 18.5 % since 2010. This figure falls short of Belgium's three neighbouring countries and most Scandinavian nations that perform better.

Belgium makes up barely 1 % of all patent applications filed with the EPO and nearly 3 % of those originating from EU28 countries. While this seems relatively modest, Belgium still ranks in the top 15 countries internationally and its share is comparable to Spain's. Thanks to sustained growth in applications, it seems quite remarkable to have consistently kept such a solid position over nearly two decades (2000-2019). This contrasts with some of the leading economies at EU or international level that have remained predominant but have lost some ground over time (e.g. the United Kingdom, Australia).

Moreover, when normalising the number of patent applications by the size of the country (e.g. its population[2]), Belgium's position slightly improves in the overall rankings[3]. But – and still considering normalised figures – some of Belgium's neighbours (Germany, the Netherlands) and the Scandinavian countries (Finland, Denmark, Sweden) continue to fare much better. Switzerland, too, holds a strong position in the relative count of patenting. But this needs to be put into context and does not necessarily reflect the underlying performance of the country's innovative fabric. Switzerland has an attractive and competitive tax regime, which explains why many innovative multinationals have set up operations in the country. In the same vein, Luxembourg also tends to show a strong position in terms of patents per capita; however, this fact is influenced by a policy

1 See the previous comment on relying on the EPO official publication data to be able to present data over the most recent years.

2 Considering other metrics such as GDP and R&D expenditure could also be used.

3 For a single patent, many applicants (or owners), as well as multiple inventors located in different countries, may be involved (a further section is dedicated to the international cooperation amongst reserachers). So an alternative counting approach to the simple count of patents should be used ('fractional counts)' which is adopted in what follows (see Annex 1 for further details).

of exempting patent and software income through an intellectual property (IP) box regime[1]. Other countries, such as the United States, naturally fall substantially in the ranking of patents per capita. China produces a negligible number of patents per capita but managed to increase that very small number by a factor of 5 over the years 2010-2016.

1 The latter was revised in 2018 but the new IP regime provides for a transition period with the old regime until 2021.

Table 1

Top 20 countries ranked according to their patent applications with the EPO[1]

(in absolute number and divided by the population in millions of inhabitants, unless otherwise stated, direct and Euro-PCT applications)

Country[2]	Applicants at EPO – Fractional count					Country[2]	Applicants at EPO – Fractional count per capita				
	2000	Rank 2000	2016	Rank 2016	Rank change 2000-2016		2000	Rank 2000	2016	Rank 2016	Rank change 2000-2016
US	32 566	1	37 054	1	0	LU	416	2	800	1	1
DE	21 187	2	21 824	2	0	CH	497	1	669	2	–1
JP	19 364	3	20 926	3	0	SE	289	4	343	3	1
FR	7 248	4	9 334	4	0	FI	316	3	277	4	–1
CN	206	22	8 145	5	17	DE	258	5	265	5	0
KR	1 125	12	6 952	6	6	NL	223	6	263	6	0
CH	3 574	6	5 599	7	–1	DK	157	7	240	7	0
UK	4 649	5	4 870	8	–3	AT	114	11	222	8	3
NL	3 557	7	4 487	9	–2	MT	31	27	186	9	18
IT	3 407	8	4 073	10	–2	JP	153	8	165	10	–2
SE	2 566	9	3 407	11	–2	IL	103	12	151	11	1
AT	916	15	1 942	12	3	**BE**	**101**	**13**	**143**	**12**	**1**
BE	**1 037**	**13**	**1 617**	**13**	**0**	FR	119	9	140	13	–4
FI	1 637	11	1 520	14	–3	KR	24	28	136	14	14
TW	255	21	1 416	15	6	IS	75	16	131	15	1
ES	613	18	1 392	16	2	US	115	10	115	16	–6
DK	841	16	1 377	17	–1	IE	71	17	112	17	0
CA	1 643	10	1 364	18	–8	NO	83	14	88	18	–4
IL	648	17	1 293	19	–2	SG	33	25	79	19	6
AU	929	14	787	20	–6	UK	79	15	74	20	–5
Others											
IE	271	20	535	22	–2	IT	60	20	67	22	–2
LU	182	23	465	24	–1	TW	12	33	60	23	10
NO	372	19	459	25	–6	CA	54	21	38	30	–9
SG	133	25	445	26	–1	AU	48	23	33	33	–10
MT	12	47	85	38	9	ES	15	31	30	34	–3
IS	21	42	44	46	–4	CN	0.2	76	6	52	24

Source : EPO (PATSTAT).

1 The country of residence is determined by the first applicant listed (first-named applicant principle). The ranking sample is composed of 182 countries. The list excludes Liechtenstein, the British Virgin Islands, Barbados, Monaco, the Cayman Islands, Bermuda, San Marino, Gibraltar and Turks and Caicos Islands.

2 The countries are ordered by numbers of patents in 2016.

1.3 Technological fields and the digitalisation break through

Looking at the type of technologies patented at the EPO, the leading sectors have tended to be modified over the last decade. This mirrors the profound changes in innovation dynamics triggered by the rise of digital technology and innovations. While medical technology was the top sector in 2010, digital communication has seen the strongest growth of patent applications since then, finally taking the top spot in 2019[1]: this reflects developments surrounding 5G technologies[2], notably under the impulse of patenting in digital information transmissions and wireless communication networks (as important enablers for 5G). The other fastest developing field over 2010-2019 was computer technology, with a very recent and steep increase fuelled by the rise of AI and in particular with machine learning and pattern recognition, image data processing and generation and data retrieval contributing to the growing number of patent applications in this field. More recently, growth in this area has been driven by various industries, not specifically from IT firms : companies active in logistics, automotive industry suppliers and medical firms have also been active, with innovation in security, medical imaging, and traffic control contributing to the increase in computer technology patent applications[3]. Besides digital, patents in new medical technologies are quickly developing with promising fields in new medical devices (implants and bionics made through 3D printing, medical imaging and diagnostics through biosensors, high-definition and virtual screening models, and personalised medicine with computer-assisted and robot-assisted surgery). Patents in the energy (e.g. batteries and electricity storage spearheaded by lithium-ion batteries for electric vehicles) and transport (e.g. energy-efficient cars) sectors are also expanding through innovation in clean and sustainable transitions. Other fast-growing patenting sectors are other special machines[4]; and others in the top ten fields are measurement and pharmaceuticals. While the former maintained robust growth over the last decade, the latter has exhibited more subdued growth since 2010 but has picked up again recently (2017-2019). Finally, patents in biotechnology and organic fine chemicals also feature in the top sectors, but applications in these areas have tended to diminish over the whole period from 2010 to 2019.

How do countries position themselves in those top patenting fields ? The anchoring of international applicants at the EPO appears relatively stronger in some sectors than in others. Digital technology, which encompasses here both digital communications (e.g. transmission of digital information and wireless communication networks) and computer technologies, is one of them and such grounding of global countries is not a new phenomenon. China became the EPO's most active applicant in 2019 (with Huawei behind the recently boosted figures). The Asian footprint is more marked in digital communications, while that of US digital tech giants – Alphabet (Google) and Microsoft – relate more to computer technologies. Together these two countries account for half of all patents in the field of digital technologies in the European market. Among the other global economies, South Korea and Japan are also prolific applicants in this field. Regarding applications originating from Europe, Sweden (Ericsson) ranks first, followed by Germany and France. Computer technology has a somewhat stronger share of patents from European countries (a third of all patents in that field in 2019) than for digital communications. Germany leads the other European countries, followed from afar by France and the United Kingdom.

Turning to the other sectors, a relatively predominant global presence is also found in areas such as medical technologies, pharmaceuticals and biotechnology. The United States is the most prolific EPO applicant in those fields, way ahead of all other countries, suggesting a sustained patenting activity of American global groups in the European market. By contrast, patents in mechanical engineering – which covers mechanical elements, machines and tools, and transport – as well as other fields such as civil engineering, continue to originate mostly from European countries, and more precisely from Germany. Interestingly, too, patents in environmental technologies are also showing a European footprint.

1 See previous comment on relying on the EPO official publication data to be able to analyse estimated patent counts for recent years.
2 See European Patent Office (2020).
3 *Ibid*.
4 "Other special machines" are part of the aggregate field "Mechanical engineering". They entail e.g. tools and machinery in agriculture, horticulture, forestry, machines for harvested food, shaping clays and other ceramic composition, working cement or stone, working of plastics and other plastic substances, manufacture of glass or minerals, preparation of chemicals.

Table 2

Top ten technology fields of all patent applications to the EPO from all world economies

(in absolute numbers, unless otherwise stated, direct and Euro-PCT applications)

Technology fields	2010	2019	Growth 2010-2019 (in %)	Ranking	
				2010	2019
Digital communication	8 410	14 175	68.5	4	1
Medical technology	11 136	13 833	24.2	1	2
Computer technology	8 649	12 774	47.7	2	3
Electrical machinery, apparatus, energy	8 530	11 255	31.9	3	4
Transport	6 364	9 635	51.4	9	5
Measurement	6 717	9 045	34.7	8	6
Pharmaceuticals	6 910	7 697	11.4	7	7
Biotechnology	7 723	6 801	–11.9	5	8
Other special machines	4 329	6 436	48.7	10	9
Organic fine chemistry	7 670	6 167	–19.6	6	10

Source : EPO.

2. Stylised facts on patent filings in Belgium

2.1 Sectoral specificities

When considering patent counts in absolute numbers and looking at the breakdown by field of technology, other special machines[1], biotechnology, pharmaceuticals, materials, transport and medical devices are the most prominent fields in Belgium's patenting activity. The composition of this portfolio varies somewhat from the other countries applying for patents at the EPO. Moreover, Belgium does not tend to be specialised in those fields that have proved to be the most dynamic in recent years (e.g. digital technologies). Rather, it is trending away from what is generally observed on the European market.

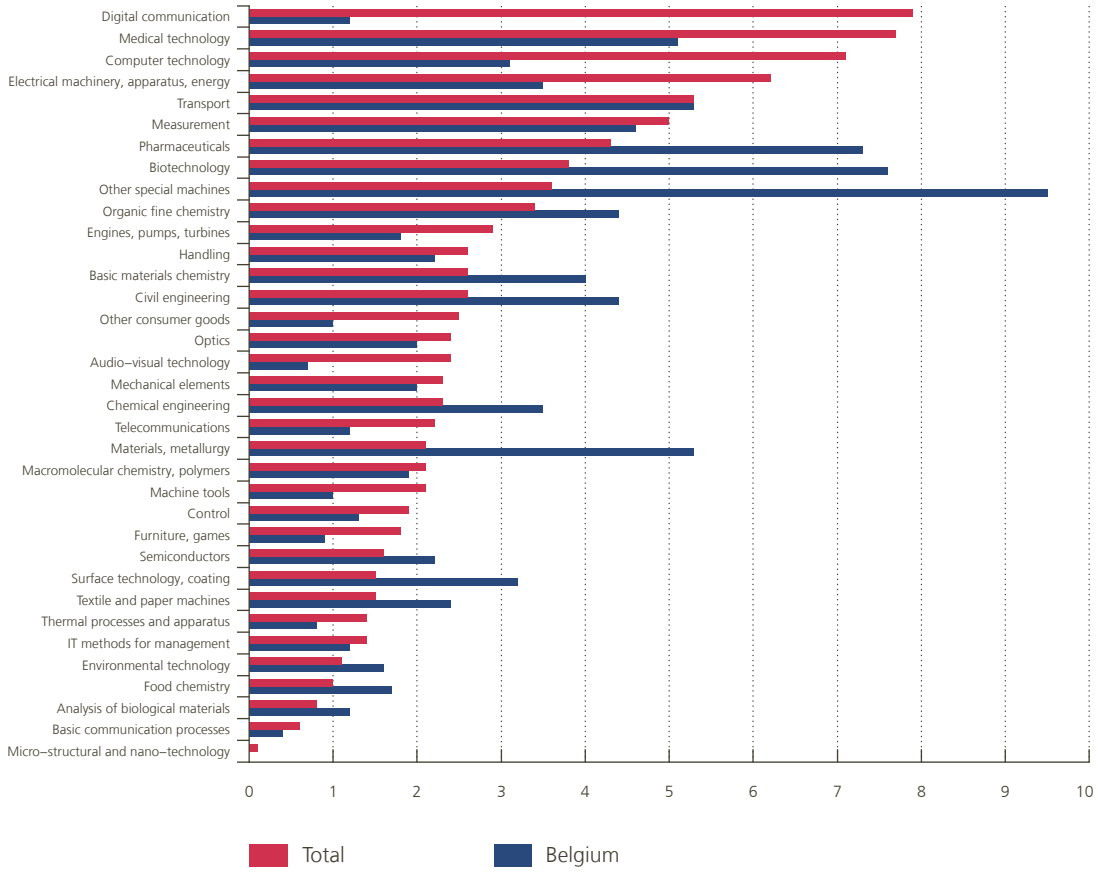
Although some of the top sectors of patenting activity in Belgium are found amongst the most important ones in the overall European market, they do not belong to the fastest-growing segments ; some even declining. This does not necessarily mean that no development towards some of the fastest-growing sectors could be observed in Belgium. In the field of digital technology, patents in Belgium grew at a similar pace over 2010-2019 (57 %) to that observed at the EPO (58 %). However, since this technology accounts for a very small part of the Belgian patent portfolio, digital tech patents remain relatively limited compared to other countries. Such sectoral distribution of patents rather resembles that of Germany for instance, where transport, electrical machinery and measurement come as its top three sectors. Broadly speaking, these domains involve research efforts aimed at industrial applications and use and relate to relatively more mature technologies. Yet, unlike Belgium, Germany holds a leading position in a broad range of technologies and represents the real European patent engine.

1 *Ibid.*

Chart 2

Top technology fields in 2019 of patent application at the EPO from all world economies and Belgium

(in % of all patents and Belgian patents at the EPO, direct and Euro-PCT applications)



Source: EPO.

The above ranking of the top technologies in which Belgium engages its innovative efforts hints at the fact that they contrast quite evidently with those breaking through and the most promising in the European market. The Belgian patenting specialisation is further analysed through the Revealed Technological Advantage (RTA) of patent applications. This indicator identifies the relative specialisation and dynamics over time of Belgium compared to other EU countries taken as a group of reference. The RTA is defined as the share of a technology in a country's overall patents, divided by the global share of this technology in all patents at the EPO[1]. Comparing the years 2010 to 2019 (hence broadly covering the last decade) makes it possible to discern whether specialisation of patents has persisted over time or whether there have been any major changes in the dynamics.

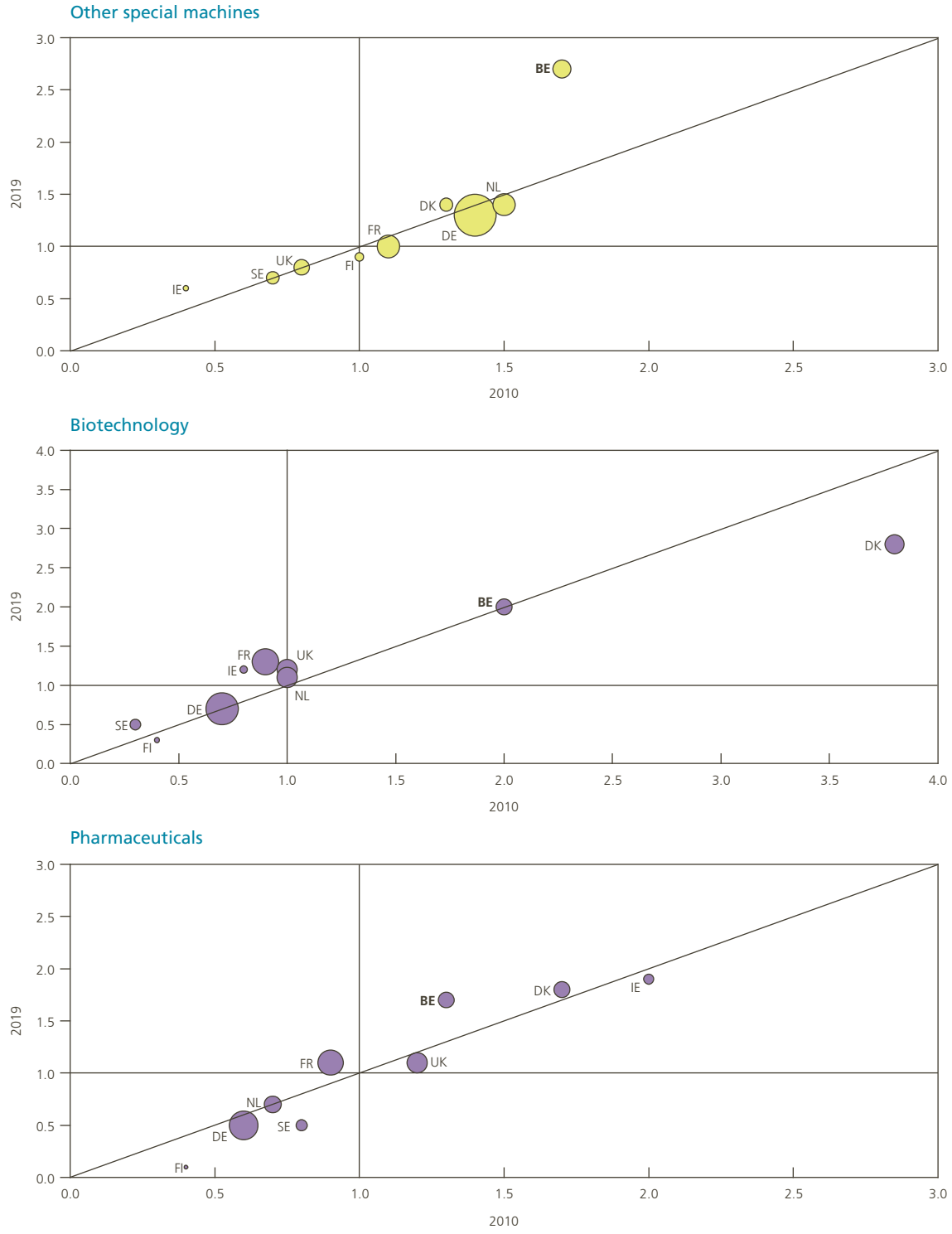
First, considering the top three fields yielding the largest patenting volumes in Belgium – i.e. other special machines, biotechnology, pharmaceuticals – Belgium's RTAs are compared to those of its European peers. Over the last decade, the country has tended to reinforce its specialised profile into other special machines. These include various types of inventions, such as new production methods in cement, plastics, polymer materials applied in petroleum product processing; but also new methods and apparatus for lasers, 3-D printing and

1 The definition resembles that of the Revealed Comparative Advantage traditionally used to analyse countries' trade specialisation.

Chart 3

Revealed Technology Advantage of the top 3 technology patenting fields of Belgium at the EPO[1]

(2010 on the x-axis, 2019 on the y-axis, direct and Euro-PCT applications)



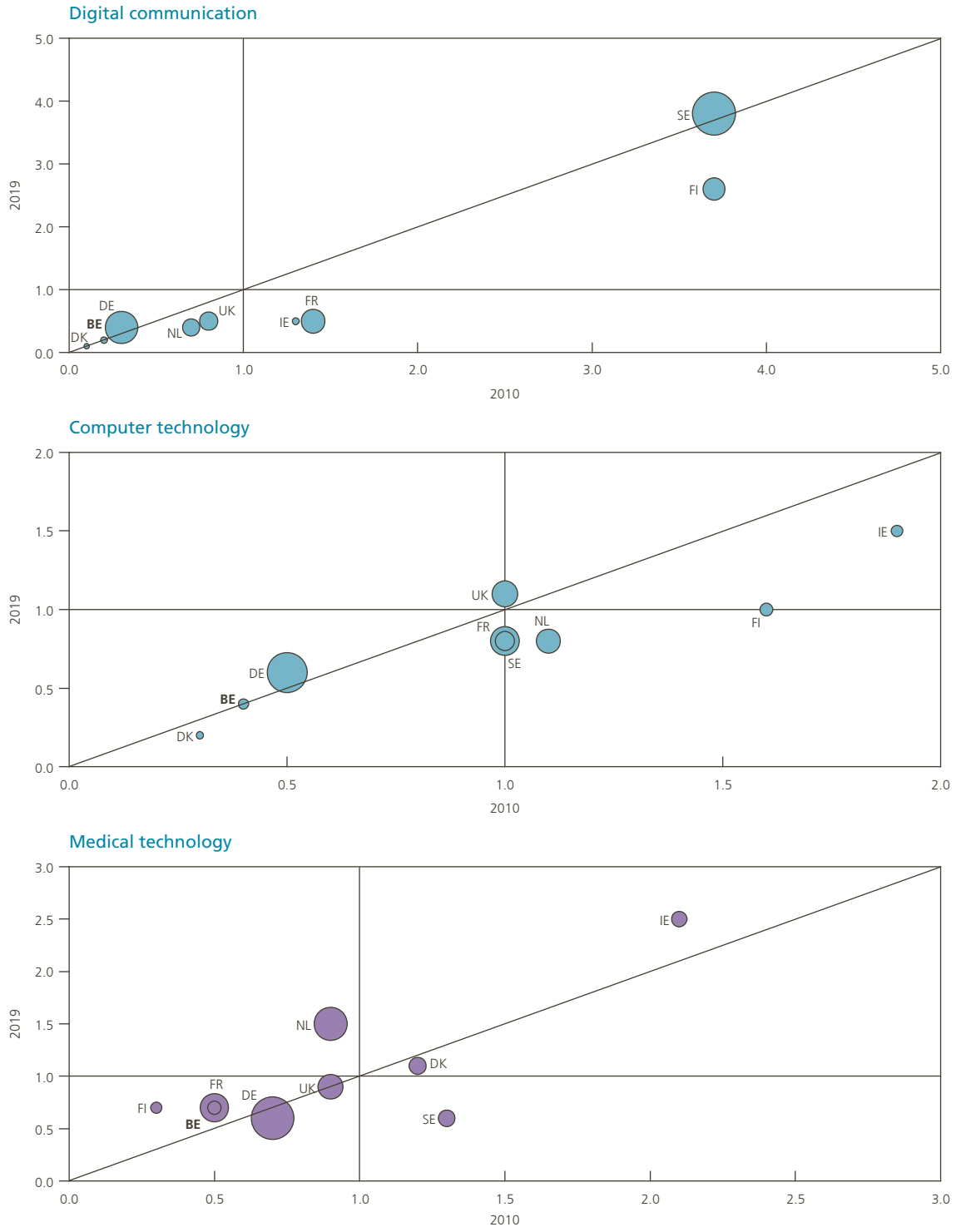
Source: EPO.

1 The size of the bubbles is proportional to the absolute number of patents from the country in the field of technology considered. An index above 1 signals a specialisation of patents in the sector considered (the higher, the more specialisation is reported). Countries above (below) the 45-degree line have reinforced (reduced) their specialisation in the technology field between 2010 and 2019.

Chart 4

Revealed Technology Advantage of the top three technology patenting fields of all countries at the EPO[1]

(2010 on the x-axis, 2019 on the y-axis, direct and Euro-PCT applications)



Source: EPO.

1 The size of the bubbles is proportional to the absolute number of patents of the country in the field of technology considered. An index above 1 signals a specialisation of patents in the sector considered (the higher, the more specialisation is reported). Countries above (below) the 45-degree line reinforced (reduced) their specialisation in the technology field between 2010 and 2019.

combine harvesters. In the other EU countries considered, the Netherlands, Germany and Denmark also exhibit some specialisation in this field, but to a much lesser extent compared to Belgium, and in a stable way over time. Belgium's specialisation in biotech patents remained strong and constant over time. The portfolio of Danish patents is relatively more orientated towards this field than Belgium, but their advantage has weakened slightly over time. Belgium also specialises in pharmaceuticals – along with Denmark and Ireland – and has bolstered this advantage relatively well over the last decade. This sector is likely to record massive changes stemming from the COVID-19 crisis. A worldwide race to find the most effective vaccines and cure available on a large scale is underway and some Belgian firms are highly involved in several projects, conveying the recognition of the high-level expertise of Belgian researchers in the field. As its favourable positioning in the pharmaceuticals RTA shows, Belgium – besides the other counties that are part of this same quadrant – can expect to be an important player in those fields in future.

Secondly, when considering, more broadly, the top three patenting sectors recorded in Europe, RTAs signal two interesting cross-country dynamics over time. First, Belgium seems chronically lacking in the patenting specialisation of digital technologies; more so for digital communications than for computer technologies. That said, the other EU countries are also not very involved in this patch of innovation, apart from Sweden (with firms like Ericsson in the lead), Ireland (Accenture Global Services and Skype) and Finland (Nokia). Still, our European peers fare far better than Belgium in computer technologies (United Kingdom, France or the Netherlands). This highlights the backlog of Belgium as an innovative place for digital technologies. That said, such a disadvantage is not irremediable: the integration of digital applications (made possible by AI advances, for instance) into the physical sectors that make up Belgium's patent specialisation can widen the opportunities for cross-fertilisation, especially since the boundaries between the use of technologies are becoming increasingly blurred (e.g. medical devices, implants and bionics made through 3D printing, autonomous vehicles integrating AI technologies). This opens the way for new opportunities offered to Belgian applicants to better position themselves by tweaking their relative advantage with the developing disruptive technologies. Second, Belgium also lags behind the reference group of countries in the field of medical technologies, even if, over time though, its specialisation in this field has grown slightly. Ireland is among the leading nations in this area. Generally speaking for the latter country, the strong position found in several sectors follows from its attractive foreign direct investment strategy as a key engine driving Irish economic development, resulting in a number of leading companies establishing their operations in its jurisdiction in sectors such as ICT, software, life sciences, engineering and business services amongst others.

2.2 The structure of patent ownership

Beyond attractive fiscal provisions driving local R&D expenditure (such as patent box systems in Belgium, which constitute interesting avenues for further research[1]), innovation dynamics in Belgium are influenced by several structural characteristics. Amongst those is the high degree of openness of the economy, which has strong implications on the constellation of patenting activities in Belgium. Other strong Belgian assets relate to its regional strategic development of major university research poles, closely collaborating with private sector entities and resulting in a few prolific technological hubs and clusters.

This section seeks to identify the types of relationships that lead Belgium into patenting activities. Broadly, it highlights that most patenting falls under the impetus of multinationals, with many foreign corporations established in Belgium. But there is also a high involvement of Belgium's own innovative fabric in research conducted abroad. Universities are also found to be an important platform for patenting work, suggesting that domestic SMEs are relatively less involved.

1 See for instance Dumont M. (2019) and Schoonackers R. (2020). Future research should also look at which part of the patenting activity in Belgium stems from intra-group transfers, some of such transactions are being partly motivated by pure optimisation strategies.

2.2.1 Who are the key Belgian owners?

Looking at the ten biggest Belgian applicants for patents at the EPO in 2019 reveals that inventions are the fruit of the research efforts of a few Belgian entities and multinationals, active in a handful of key sectors (e.g. chemicals, pharmaceuticals and biotech industries). Broadly speaking, almost 40 % of patents filed at the EPO are in the hands of the top ten Belgian players, which testifies to the concentrated nature of patenting. This finding overlaps with that already established on the upstream side of Belgian innovation and R&D expenditure more broadly[1].

Even if at this stage we intentionally disregard the foreign presence in the top ten presented – in order to focus solely on the main Belgian patenters – it already appears that some of the principal patenters are co-owned by foreign companies (e.g. Agfa, AB InBev) and continued to operate from Belgium, a reflection of their mergers and acquisitions history. A common denominator for most of them is that they have established foreign facilities or are involved in collaboration projects with inventors located in other countries[2].

The presence of universities, their spin-offs or consortia with private entities, is also apparent. Some of them may also be interconnected (e.g. the VIB (*Vlaams instituut voor biotechnologie*) is the outcome of collaboration between five universities in Flanders – Ghent University, KU Leuven, University of Antwerp, Vrije Universiteit Brussel and Hasselt University – in life sciences research). The consolidation of all records of their inventive activities – inter-universities themselves, or with some of the top private patenting companies – naturally translates into higher volumes in patent application counts. The next sections of this article further reflect on the main features detected through the top ten Belgian patent applicants.

1 See Vennix S. (2019).

2 In fact, among Belgian applicants, one can distinguish between (i) Belgian-based firms with affiliates abroad – which are listed in the table here – and (ii) affiliates of foreign firms located in Belgium; see Cincera M. *et al.* (2005).

Table 3

Top ten Belgian applicants of patents filed at the EPO in 2019[1]

(in absolute number and in % of total patents)

Rank	Company	Number of patents in 2019	In % of total patents in 2019	Technological field of companies or other type of entity
1	SOLVAY SA	306	12.6	Chemicals and plastics
2	IMEC VZW	174	7.2	Micro- and nano-electronics, digital technologies
3	UMICORE NV	89	3.7	Metals and mining
4	K.U. LEUVEN	70	2.9	University
5	UNIVERSITEIT GENT	67	2.8	University
6	AGFA NV	56	2.3	Imaging and IT systems
7	MELEXIS NV	48	2.0	Micro-electronic semiconductors
8	VIB VZW	44	1.8	Biotechnology
9	VITO NV	40	1.7	Energy, chemistry, materials, health and land use
10	ANHEUSER-BUSCH INBEV NV	34	1.4	Instruments in beverages
Total		2 423	38.3	

Source: EPO.

1 This is the ranking of the main consolidated applicants at the EPO in 2019 (first-named applicant principle). It is based on direct and Euro-PCT applications filed with the EPO during the reporting period.
IMEC: *Interuniversity Microelectronics Centre*, VIB: *Vlaams Instituut voor Biotechnologie*, VITO: *Vlaamse Instelling voor Technologisch Onderzoek*.

2.2.2 Cross-border ownership and international collaboration

Without being a strict prerogative of Belgium, innovative activities are becoming increasingly globalised as more and more research initiatives are organised in multiple countries. Researchers with specialised knowledge in complementary fields may collaborate in a scientific consortium project based on their respective comparative advantages, creating synergies. Such projects are usually of higher value and bear larger costs. Purely relying on domestic resources can act as a constraint. Besides, many other considerations contribute to the attraction of a country and come into play to determine the constellation of countries and research units involved, such as favourable IP and tax regimes, the availability of a highly-educated workforce, and local innovative hubs or specific know-how in the sectors of interest.

Apart from research alliances, the ownership of innovation may involve distinct entities established in several countries, and such cross-border ownerships actually encompass a large spectrum of possible cases. Inventions made by a domestic resident can be owned by a foreign firm : as in the case of a Belgian inventor employed by an American company because that company will ultimately come to own the patent produced by the Belgian employee. Likewise, a domestic company, e.g. a Belgium firm with a branch or with a laboratory established abroad, may employ inventors residing in another country – for example, an Italian inventor working for a Belgian pharmaceuticals company, in which case the patent produced is the intellectual property of the Belgian firm. Differences observed between the owner and the inventor of a patent can thus be a sign of multinationals' activities and/or of intensive international cooperation.

Such international relationships may be considered as a form of technology diffusion [1]. Innovative firms may wish to establish itself in a country to penetrate the local market and adapt its products to it ; this strategy of proximity may be accompanied by the provision of technological support to the local subsidiaries that adopt the new processes of the foreign firm. Ultimately, this results in technological transfers that could benefit the recipient country. An alternative strategy is that firms eager to closely monitor a specific technology could tap into and target the foreign local know-how. In this case, the flow of technology is reversed and leads to a knowledge transfer in favour of the investing country.

In this section, cross-border ownership strategies and research collaborations are analysed. We compare Belgium to other European countries, enabling us to sketch out some of the typical Belgian features. What comes across clearly is that international ownership structures primes somewhat over that of Belgian-owned inventions (whether conceived domestically or abroad). Besides this, Belgium is highly involved in international research collaboration.

- Cross-border ownership of patents

Recourse to a patent database is particularly helpful to capture cross-border ownership as it involves detailed information included in patent documents, namely : the applicant that owns the patent, the inventor that created it and their respective geographical locations. When the applicants' and inventors' country of residence differ, this signals the existence of a cross-border ownership. There are two different aspects to it : international ownership over locally produced patents and, conversely, domestic ownership over international inventions performed abroad.

First, **foreign ownership of domestic inventions** reflects the extent to which international firms have a substantial influence over domestic inventions. Without being a new phenomenon, it may result from a wide range of strategies and business choices [2]. For instance, multinationals, mergers and joint ventures between firms of different nationalities may choose to establish their research facilities in one country of the parties involved for different reasons. The decision processes take into consideration the benefits from drawing on adequate local

1 See Guellec D. and B. van Pottelsberghe (2001).
2 *Ibid*.

Table 4

Foreign ownership of domestic inventions

(in % of domestically invented patents filed at the EPO, average over periods)

Country	2000-2004	2005-2009	2010-2014	2015-2016
DE	16.2	17.9	18.1	18.1
DK	24.9	24.7	26.1	20.8
FI	13.1	18.1	18.0	20.9
NL	23.2	27.8	25.2	21.2
FR	25.9	24.8	22.6	21.5
IT	19.4	21.8	23.9	22.1
CH	26.0	27.9	24.6	22.9
SE	22.5	24.5	24.7	24.9
AT	40.2	37.2	30.2	32.5
ES	33.0	30.2	31.7	35.0
BE [1]	**46.4**	**46.4**	**44.9**	**39.7**
UK	41.9	42.0	43.9	40.1
LU	60.7	47.7	53.0	49.8
IE	43.0	40.9	47.2	52.3

Source: OECD.

1 Over the whole period the top five companies are: Electrolux Home Products Corporation, Janssen Pharmaceutica (Belgian subsidiary of Johnson & Johnson), Case New Holland, Agfa-Gevaert, GlaxoSmithKline Biologicals.

human capital, the opportunity to penetrate a network of researchers backing up the firms' core technology or to strategically develop a new one. The presence of infrastructure and proximity to hubs, as well as national R&D systems make the host country more attractive.

The OECD [1] provides comparable percentages across countries of patents owned by foreign residents. The concept of foreign ownership over domestic patents can be measured by the SHIA indicator, defined as the share of patents held by foreign residents in the total fractional number of patents invented by residents [2]. The larger countries such as Germany, France and Italy display lower ratios, suggesting a smaller propensity for their patents to be held by non-residents and that they tend to master their own inventions and collaborate more locally. Interestingly, the Netherlands and some Scandinavian countries (to a lesser extent in Sweden's case) also tend to be characterised by less foreign ownership of their domestic patents.

Conversely, Belgium belongs to the group of countries where the ratio is amongst the highest. This signals that foreign companies tend to hold quite a lot of domestic innovations there: nearly four out of ten Belgian patents are in international hands [3]. In this same group of countries though, others display an even stronger international ownership, such as Ireland, Luxembourg and the United Kingdom. It is worth mentioning too that, since 2010, the ratio in Belgium has tended to decline slightly – but has remained quite high –, potentially signalling a resumed taking back of patents' property from domestic firms in Belgium. However,

1 OECD database on Science Technology and Patents.

2 Defined in Guellec D. and B. van Pottelsberghe (2001).

3 Cincera M. *et al.* (2005) further find that a large part of patents with Belgian inventors are in fact assigned to Belgian affiliates of foreign firms.

Table 5

Domestic ownership of patents made abroad

(in % of domestically owned patents filed at the EPO, average over periods)

Country	2000-2004	2005-2009	2010-2014	2015-2016
IT	6.4	6.2	7.2	7.8
ES	7.7	9.5	10.1	10.6
DE	14.0	16.5	17.6	17.0
FR	21.1	22.1	22.6	18.9
UK	21.5	21.0	21.5	20.9
DK	23.0	23.9	28.0	24.5
AT	29.1	24.1	24.6	25.1
FI	27.9	34.2	30.0	28.5
NL	38.8	38.9	34.8	33.4
BE	**35.7**	**41.7**	**40.6**	**34.0**
SE	**32.5**	**35.8**	**38.7**	**35.4**
CH	53.5	58.8	58.0	56.3
IE	60.9	64.9	65.4	65.2
LU	87.3	90.0	93.5	87.9

Source: OECD.

this could also relate to companies having established themselves on Belgian territory, creating a Belgian entity from a joint ownership within their multinational structures, or to foreign firms establishing their European operating base in Belgium (e.g. Toyota Motor Europe).

Secondly, **domestic ownership of patents invented abroad** reflects the extent to which domestic firms hold inventions produced by residents abroad, which is the flip side of the above concept. Based on the SHAI indicator[1] – defined as the share of patents owned by country residents, with at least one foreign inventor in the total patents owned by the resident country – the OECD data highlights a contrasting picture between European countries. In a way, this indicator also signals the extent to which countries have been successful in appropriating the returns of knowledge produced elsewhere – a form of technology flow to the benefit of domestic resident entities.

Belgium continues to exhibit relatively higher ratios, indicating that more than a third of patents held by Belgian entities were co-invented with a foreign researcher. This is in fact not surprising, given the high involvement of Belgian inventors in international research collaboration (which will be further addressed below), the indicators are not independent from one another. The two measures of cross-border ownership are quite high and similar in the case of Belgium, which hints at a mixed strategy from the firms involved.

When plotting domestic against non-domestic patent ownership over the most recent period available in the data (2015-2016), the predominant pattern between countries is immediately perceptible: countries above (below) the diagonal – in the north-west (south-east) quadrant – tend to exhibit a wider domestic (international) ownership base for their patents. This frame reveals that, in Belgium, the foreign dimension

1 Defined in Guellec D. and B. van Pottelsberghe (2001).

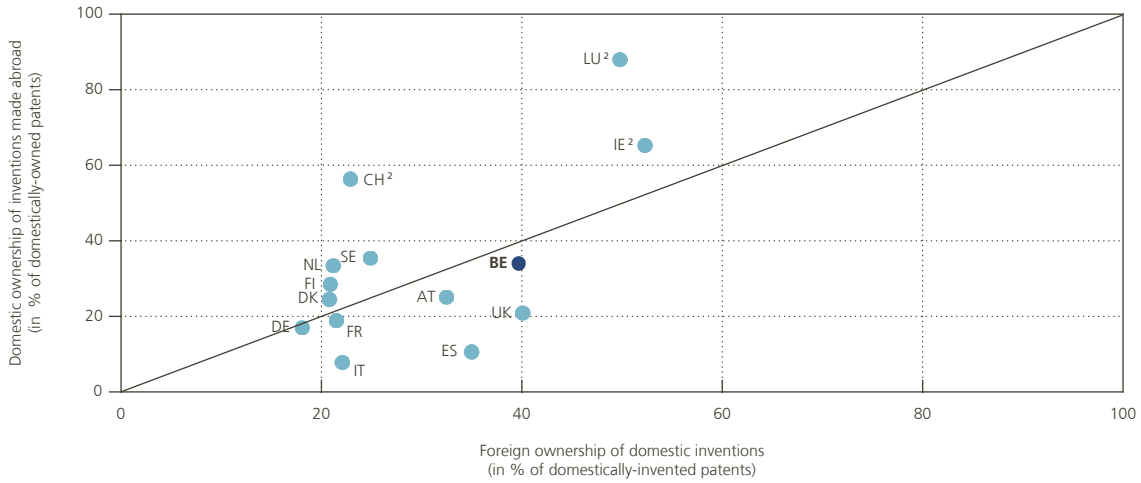
tended to overtake that of domestic ownership in those last two years considered. In the other EU countries, the scatter plot further shows that large economies such as Germany and France display low ratios of domestic ownership, more or less in line with international ratios. By contrast, patents from Spain and Italy tend to be relatively more prone to external rather than domestic ownership. Even if some variations amongst them are visible, the Scandinavian countries are all situated in a quadrant where patents remain to a larger extent within the domestic sphere. Finally, and in contrast to Belgium, Switzerland, Ireland and Luxembourg are small open economies where multinationals have established as national residents. They benefit from a significant number of inventions made abroad under their supervision; yet, these are strongly influenced by some of their national provisions making them highly attractive for global companies that have established business operations in their jurisdiction thanks to the FDI-led strategy in Ireland, competitive general tax regimes in Switzerland and Luxembourg and an even more attractive IP box regime in Ireland and Luxembourg.

Broadly considering the countries above the diagonal of the scatter plot, these correspond to a group with the largest R&D expenditure and suggests that innovative countries are also the ones that tend to have a stronger hold over both domestic and foreign inventions. In other words, the more a country is engaged in research and innovation efforts, the more it tends to exert a form of control over its patents. As well as being R&D-intensive, the education system is likely to play an important role and make a substantial contribution to these results too, through the fact that it is able to provide sufficient capacity to absorb and use new knowledge thanks to the available and adequate qualified workforce. In the chart, Belgium does not belong to this group, highlighting a missed opportunity from its internationalisation of innovation: knowledge created by Belgian inventors, wherever they operate, to some extent flows out towards foreign owners, reflecting that the country is not fully mastering the associated returns from its own patent efforts.

Chart 5

Domestic vs foreign ownership of patents

(in % of patent applications filed at the EPO, average in 2015-2016)[1]



Source: OECD.

1 Countries above (below) the 45-degree line tend to exhibit a larger domestic (foreign) ownership base of their patents.

2 The high domestic ownership performance of Luxembourg, Switzerland and Ireland is strongly influenced by some of their national provisions making them highly attractive for global companies to establish their business operations there.

International collaborations in patents

As mentioned above, scientific research and projects are increasingly shifting from single or individual concerns to groups of laboratories or research units established in several countries and where mutual expertise can complement one another through interdisciplinarity. International collaboration resulting in transnational research can be measured by the SHII indicator[1], defined as the share of patents co-invented by a domestic researcher and another that is resident in another country in the total number of patents invented domestically.

Belgium's ratios stand out from those of its neighbours and the Scandinavian countries. This highlights one of the key features of innovation in Belgium, namely the high degree of openness and international collaboration: more than a third of Belgian inventions stem from international teamwork with other inventors abroad. Switzerland, Ireland and even more so Luxembourg also have similar attributes. This comes as no surprise, since smaller open economies tend to benefit from larger economies of scale from joining a network of researchers rather than purely relying on domestic resources. Larger European countries (Italy, Germany, France) tend to benefit from a wider pool of domestic researchers and have smaller ratios.

The close international cooperation that Belgium is known for is not only a matter of inter-firm collaboration, it also stems from intra-group global strategies. Whatever form it takes, being highly integrated into global research networks that produce patents is likely to encourage technology diffusion benefiting such a small open country. Without necessarily being the original producer of patents, Belgium still contributes to the advanced technologies developed and gains from the foreign spillovers of such collaboration. This also reflects the recognition of the skills and value of Belgian inventors and researchers and their attractiveness to foreign

1 Defined in Guellec D. and B. Van Pottelsberghe (2001).

Table 6

Share of international co-inventions of patents

(in % of domestically invented patents filed at the EPO, average over periods)

Country	2000-2004	2005-2009	2010-2014	2015-2016
IT	10.5	11.0	12.4	12.8
DE	13.1	14.7	15.0	14.7
FR	17.4	19.1	18.1	17.2
NL	17.5	19.3	18.4	17.8
FI	14.7	19.5	18.4	19.2
DK	21.3	20.0	21.4	19.8
SE	17.5	20.4	22.3	21.7
ES	22.4	21.5	20.1	22.8
UK	24.1	25.8	25.7	23.4
AT	27.2	26.5	27.3	29.0
BE	**36.4**	**38.4**	**37.1**	**34.4**
CH	33.7	37.5	37.2	36.1
IE	34.2	34.7	35.9	36.3
LU	53.6	56.4	69.2	58.1

Source: OECD.

multinationals seeking to work with them. What will be crucial is to be closely involved in those high-value technological innovations and to be able to move up the ladder as new technologies and important scientific advances emerge (green tech, digital, health treatments and vaccines against COVID-19, etc.).

But on the flipside, and unlike other small economies, Belgium does not seem to have been able to fully appropriate the returns from the knowledge created domestically and abroad. This is a source of vulnerability and dependence upon external entities at a time of huge uncertainty, not least because of deglobalisation fears and reshuffling of supply chains in a wide range of industries, but also because of the changing underlying dynamics of innovation, tilting towards digital and health innovative treatment therapy in the context of the coronavirus pandemic.

2.2.3 The role of universities

The reporting of applicants' institutional sector in patent documents enables universities to be identified amongst the reported categories of applicants[1]. In what follows, we only consider *university-owned* patents. Over the period 2000-2016, the number of patent applications at the EPO involving universities as their applicant has more than doubled, highlighting the sharp increase in academic patenting over the last few decades, first in the United States, then in Europe[2]. Below, we reflect on the relative importance of universities in patenting activity in several European countries and in Belgium.

Before commenting on the findings, one should be aware that such statistics are largely influenced by the heterogeneous IP regimes in place nationally, and that not all academic inventions are patented under the name of the university, but rather under the individual researchers themselves: as a result, comparing the data of university-owned patents across European countries can be misleading for some countries. The principal illustration of it is that Finland, and even more so Sweden, exhibit strikingly low ratios. Of course, this should not be interpreted as Finnish and Swedish universities having a weaker innovative capacity than elsewhere. The relatively low figures are largely attributable to the bias relating to their IP regime governing university inventions and related ownership rules in those countries. National regimes were in fact still very diverse in

1 A patent may be assigned to a combination of one or more of the following entities: individual, company, government, non-profit, university, hospital. We considered universities at large, i.e. including any grouping of the sectors where they are reported as the only owner or as the co-owner of a patent (e.g. company-university).

2 See van Zeebroeck N. *et al.* (2008).

Table 7

Universities' ownership of patent applications at the EPO

(direct and Euro-PCT applications, average over 2006-2016)

Country	All patents of the country (in %)	Inhabitants (in millions)	Country	All patents of the country (in %)	Inhabitants (in millions)
CH	2.6	18.3	AT	2.9	5.8
BE	**11.6**	**17.2**	UK	7.5	5.6
IE	11.4	13.2	FI[1]	0.8	2.7
DK	4.8	12.0	LU	0.3	2.7
FR	4.6	7.1	ES	7.9	2.4
NL	2.6	7.0	IT	2.3	1.6
DE	2.1	6.3	SE[1]	0.1	0.4

Source: EPO (PATSTAT).

1 Finland was one of the last European countries to abolish the "professor's privilege" (in 2007); it is still currently effective in Sweden.

Europe at the end of the 1990s and only began to converge – even imperfectly – in the early 2000s. It was precisely institutional differences of academic patents that were highlighted by the "European paradox" to explain Europe's lag behind the United States[1]. Several countries (Denmark, Germany, Austria, and much later Finland) introduced some legislative changes in the 2000s by repealing the so-called "professor's privilege", which allows university researchers to retain ownership of their inventions, while others like Sweden retained it[2].This explains the weak figures for some countries and their corresponding large pool of patents filed by academics as individuals (but not listed as universities)[3]. In fact, when one considers the other definition of academic patents[4], according to which any inventions where a research university scientist has contributed to some degree amongst the inventors of a patent, the result is very different: Sweden has a much higher share of academic patents than the figures for university-owned patents suggest[5]. Data for university-owned patents presented here therefore only show a lower bound estimate of the patenting performance of universities[6].

Once this caveat is borne in mind, the figures can give us some information for countries where IP regimes allow university-owned patents. Overall, on average over the ten years from 2006 to 2016, the weight of universities in all patents was highest in Belgium and Ireland. Once such patents are considered in per capita terms, Switzerland and Denmark join those two countries in a group with a solid university performance (and as reported through their national IP regimes).

Considering Belgium more specifically, both high figures signal an active role of universities in patenting activity. The most important technology areas in which Belgian universities are active are electronics (e.g. semiconductor devices), medicinal and pharmaceutical preparations (e.g. specific therapeutic treatments), organic and biochemistry (e.g. genetics) and physics (e.g. instruments, measuring or testing processes, optical devices). In line with the findings in the previous sections, this does not come as any surprise since some of the technology fields in which Belgium is relatively more specialised (biotech, pharmaceuticals, some domains in chemicals and instruments of measurement) require more fundamental research. Especially since legal dispositions around the "professor's privilege" ended throughout Europe, and more specifically in Belgium since the introduction of stronger enforcement of the institutional ownership system already in place[7], this finding actually echoes the emergence of research laboratories and universities amongst the key stakeholders on which a society's innovative potential can count. The rising entrepreneurial orientation among academia puts the country in an advantageous position in emerging knowledge-intensive fields of economic activity, through more intense marketing of research results, patenting and licensing activities, or managerial and attitudinal changes among academics towards collaborative projects with industry[8].

When looking at a sample of the most cited patents in which Belgian universities were involved, they tend to come from partnerships rather than a unique entity. Domestic inter-university research is quite wide (e.g. IMEC or VIB are themselves involved in cooperation with other Belgian universities) which produces an overall high volume of patents recorded by this sector. That said, there is also cooperation with foreign entities, further evidence of the strong international research collaboration of Belgium as a core characteristic of its innovative fabric (see above). Besides this, universities also tend to be part of a strong nexus through partnerships with private companies. On the flipside of such a strong role for Belgian universities, Belgian companies, especially SMEs, appear to make relatively less effort. This echoes the observation of a lack of entrepreneurship in the Belgian economic fabric more generally[9].

1 According to the European paradox, despite a strong science base in European countries, scientific advances were less successfully translating into commercially viable new technologies. The Bayh-Dole Act in the US in 1980, along with other incentives introduced at the time, allowed universities to have the right to own the patents on inventions financed by federal public funds and to become the exclusive providers of licences to third parties. In its aftermath, there was a surge of US patents filed by universities and their research marketing, which brought support in some European countries to replicate such a system (see Lissoni F. *et al.* (2008) and Martinez C. and V. Sterzi (2020)).

2 See Martinez C. and V. Sterzi (2020).

3 These are not presented in this article.

4 Following the definition of Lissoni F. and F. Montobbio (2015).

5 See Lissoni F. *et al.* (2008). In principle, *academic* patents should be considered in order to properly assess the role of academic research in the innovative activity of the different European countries. However, this exercise requires further step-by-step work of matching the inventors' names to a national list of listed academic professors, which falls outside the scope of this article.

6 See van Zeebroeck N. *et al.* (2008).

7 See Martinez C. and V. Sterzi (2020).

8 See Van Looy B. *et al.* (2011).

9 See previous editions of NBB Annual Reports and De Mulder J. and H. Godefroid (2016).

2.3 Measurement issues and introducing the notion of patent value

Patents filed at a given patent office provide a rich source of data, but they also bear many statistical limitations and should be interpreted with caution. The main ones are chiefly reviewed below.

First, the so-called "*home bias*", which refers to the fact that domestic applicants tend to file more patents in their home country (than non-resident ones), rather than applying for an initial patent request in another country or market. For instance, innovative firms from the United States are more likely to seek protection of their innovation by filling a patent application at their own national office. That said, the geographical and cultural proximity, as well as the home market size, also influence the decision to patent in the most prominent offices, e.g. some Canadian or Mexican firms may be more likely to first file an application in the United States before extending it to their own national office[1]. In addition, the overall fees required throughout the whole patenting procedure at the offices may involve a large spectrum of varying costs, from validation, renewal and translation fees, which are likely to further affect the behaviour and choice of the patent office by applicants. This is particularly true for the still fragmented system prevailing in Europe[2]. Second, some sectors and technologies are more prone to be patented than others, resulting in *variable propensities to patent across industries*. This is the case, for instance, for technologies where basic research and R&D are central, naturally resulting in a higher volume of patents. On top of this, filing strategies may also influence the extent to which firms in a given sector are more likely to file a very high number of patents for any given invention[3]. Third, the same holds true for *the size of the company* considered: the larger ones will encounter less difficulty in covering the various costs associated with patenting procedures than SMEs or new arrivals to the market. Fourth, because of legal rules governing the application process, information on patents is generally only disclosed publicly after 18 months (as a "priority" filing): patent indicators are typically and intrinsically associated with a *timeliness issue* which can extend to more than five years depending on the route taken and the offices chosen (see Annex 1 for further definitions). Finally, *varying regulations governing patent offices and procedures* may complicate the comparability of patent counts across countries and influence the propensities to patent. The international heterogeneity of operational designs may ultimately lead to different degrees of rigour and transparency in patent selection processes (which can be referred to as the "quality" of a patent examination process); and evidence shows that the propensity to patent is lower in those systems with a higher quality index[4]. Changes in patent laws over time further add to such difficulties. So, patent counts across different offices are usually not directly comparable for correctly assessing countries' performance. For this reason (amongst others) and to get round this limitation, our analysis throughout this article has been based on a single office of reference (EPO).

In addition to the above, patents typically display a *skewed distribution value*, i.e. only a few inventions have high technical and economic values, while many are never used and some simply turn out to have no industrial application, so are of little value to society. Many inventions are also not patented simply because they are not patentable or because inventors chose to protect the inventions through other instruments such as secrecy agreements (see box for a review of other types of practices). It follows that a simple count using the same weight for all patents regardless of their value can therefore give a truncated view of their underlying reality. It may be that less intensive production of patents in a country – for instance Belgium compared to its neighbouring countries – may be compensated by inventions of higher quality.

1 See OECD (2009).

2 Once a patent is granted by the EPO, the assignee must validate and eventually translate it, and additionally in the future pay the renewal fees to keep it in force in each country in which protection is sought. See Annex 1 and Harhoff D. *et al.* (2009).

3 As Danguy J. *et al.* (2014) describe, this extra dimension of filing strategies contributes to explain part of sectoral differences in propensities to patents, even when two technologies are already characterised by a high appropriability strategy (e.g. in the telecommunications industry, firms typically have numerous patents per innovation; by contrast, drugs in the pharmaceuticals industry are generally protected by a small number of key patents).

4 See de Saint-Georges M. and B. van Pottelsberghe de la Potterie (2013).

The value of patents is nevertheless a complex notion that can be defined in several ways or concepts[1]. A whole range of patent indicators was found to be associated with the largest economic impact and to capture different dimensions of patent value[2], including:

- the *renewal fees* over the lifetime of a patent, indicating that the expected revenues from extending the protection are higher than the costs incurred[3],
- the *number of inventors* associated with the patent, as a proxy for the overall cost of the research involved,
- the *forward citations* of a patent, which is the number of citations a patent receives in other subsequent patent applications, indicating the technological impact that the initial patent had on all downstream research further developed in a field,
- the *geographic coverage* of a patent, which is the number of applications recorded across the different offices of international jurisdictions, commonly referred to as the *family size*. Applying for a patent abroad with a view to seeking protection in numerous geographical markets is usually a sign of higher economic value and greater potential for marketing and profit despite the multiple costs incurred,
- the *opposition incidences* of a patent, or the possibility for third parties to challenge the grant of a patent within a certain period of time provided by the applicable law and closely relates to the EPO's patent granting procedure. As opposition is a costly and risky process, a patent that is opposed can therefore be seen as an indicator of its higher market value[4].

In what follows, we shed some light on one of them – the family size –, without necessarily implying that the latter is exclusive or preferable to the others mentioned above. It is presented for illustrative purposes only and should ideally be supplemented by other types of indicators to provide a better and comprehensive view of patent values.

Triadic family patents are defined by the OECD as "the set of patents taken at the European Patent Office (EPO), the Japan Patent Office (JPO) and the US Patent and Trademark Office (USPTO) that protect the same invention"[5]. Since only patents applied for in all three offices are included, the measurement issues of home bias and influence of geographical location mentioned above are eliminated. The OECD triadic patent family indicator considerably improves the quality and international comparability of patent indicators[6].

Being those with the highest economic value and worth being protected in the three most important international markets, triadic patents usually stem from larger firms (like multinationals) which are able to bear the costs of the application processes and have made the strategic choice to give their invention the broadest possible protection. In the same spirit, at this triadic and therefore costly level of patent filing, only those technologies that are likely to be profitable on the market tend to feature in the triadic patent portfolio. When looking at the allocation of triadic patents by country, Belgium seems to be in line with other European economies such as Spain or the Scandinavian countries, but still far below our three neighbouring countries. Even when triadic patents are standardised by the population, the position of Belgium does not fundamentally improve compared to the group of reference countries, and stands even below average. This contrasts with the results of section 1.2. for 'regular' patents. Moreover, Belgian triadic patents per capita have tended fall back over time; that said, this observation also hold for most of the other EU countries considered. The sectoral allocation of Belgium's triadic patents shows that the most important technology is chemistry

1 The economic value of the patent holder is the discounted revenue flows generated by the patent over its lifetime. The social value of the patent relates to its contribution to society's stock of technology.

2 van Zeebroeck N. and B. Van Pottelsberghe de la Potterie (2001) further show that some filing strategies (such as the structure and quality of the drafted document, the filing of divisional applications and the route chosen) are positively associated with the different measures of patent value discussed here.

3 At the end of each period of the exclusive right of the patent, holders choose whether they renew and prolong the right to exclusivity. This can be opted in several geographical jurisdictions where the patent is protected, resulting in corresponding accumulated costs.

4 See OECD (2009).

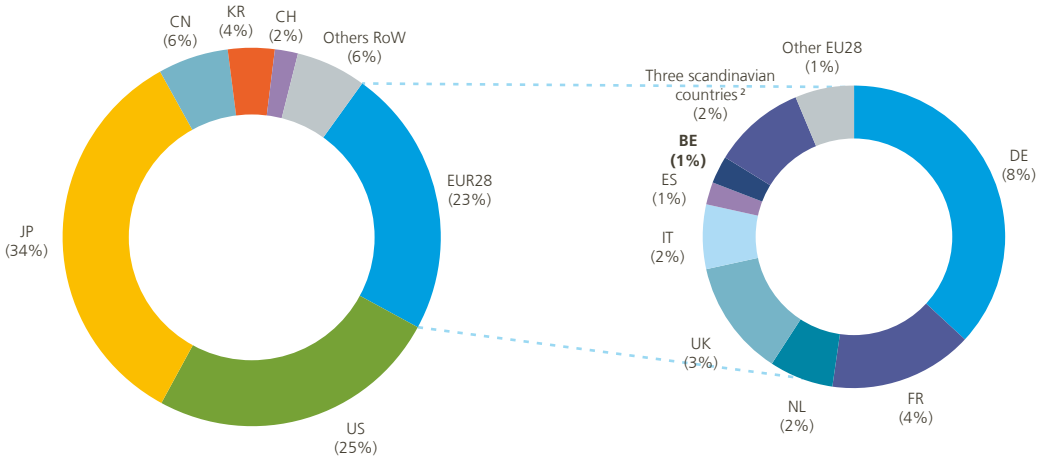
5 See extensive OECD work and database https://data.oecd.org/rd/triadic-patent-families.htm, based on Dernis, H. and M. Khan (2004).

6 de Rassenfosse G. and B. van Pottelsberghe de la Potterie (2009) further show that triadic patents are a good indicator of countries' research productivity compared to indicators of priority filings of patents, the latter being affected by variations in the propensity to patent across countries.

Chart 6

Share of countries in triadic patents[1]

(in % of all triadic patents, 2016)



Source: OECD Triadic Patent Families database, July 2020.

1 Following the OECD methodology (see Dernis, H. and M. Khan (2004) and OECD (2009)) to reflect the inventive performance of countries, triadic patent families are counted according to the earliest priority date (first patent application worldwide), the inventor's country of residence in order to reflect the local inventiveness of the local labour force (researchers, laboratories, etc.), and fractional counts.

2 Denmark, Finland, Sweden.

Table 8

Triadic patents per capita[1]

(divided by the population in millions of habitants, average over periods)

Country	2000-2004	2005-2009	2010-2014	2015-2016
CH	140.5	137.7	139.1	132.4
SE	87.4	97.1	66.8	67.4
NL	104.7	79.0	62.8	54.9
DE	86.2	74.2	59.5	52.9
DK	57.2	59.5	50.6	49.0
FI	73.6	53.9	49.1	44.7
LU	50.8	42.0	37.4	43.6
AT	34.5	44.7	45.2	40.5
BE	**46.4**	**45.0**	**39.4**	**32.6**
FR	46.0	44.8	37.8	29.5
UK	37.6	31.0	27.0	22.9
IE	18.1	19.9	18.0	19.5
IT	15.9	13.7	12.4	12.8
ES	5.4	5.9	5.1	5.9

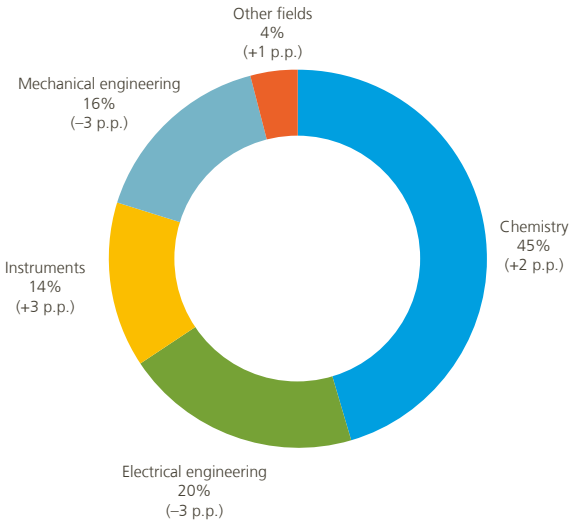
Source: OECD Triadic Patent Families database, July 2020.

1 Following the OECD methodology (see Dernis H. and M. Khan (2004) and OECD (2009)) to reflect the inventive performance of countries, triadic patent families are counted according to the earliest priority date (first patent application worldwide), the inventor's country of residence in order to reflect the local inventiveness of the local labour force (researchers, laboratories, etc.) and fractional counts.

Chart 7

Allocation of triadic patents by main technology fields in Belgium

(in % of Belgian triadic patents, average 2015-2016, figures in brackets are in percentage points and in comparison to the average share in 2000-2004)



Source: OECD Triadic Patent Families database, July 2020.

BOX 1

Licensing and complementary practices to patents

Going back to the original question as to why firms patent in the first place, it is obvious that the patentee may benefit from various advantages and perks. By benefiting from exclusive protection, the patenting company first and foremost gains the monopoly and privilege to use a technology and hold all the economic returns associated with its in-house exploitation[1]. In addition, patents also bring other types of rewards or revenues: they can be used strategically, for instance to stop incumbents from copying a technology or adopting it. In this way, patents can act as a counter-diffusing factor of knowledge flows. However, it may not always necessarily be the case, because getting a patent requires technical information about the invention to be disclosed to the public in the patent application document. Furthermore, patents can be marketed, meaning that the intellectual property right to use the new technology can be transferred to other companies. This opens the debate about other instruments used to protect intellectual property (IP).

1 This also contributes to giving firms an incentive to get involved in R&D and innovation efforts.

Besides the wish to hold a monopoly rent and prevent technology imitation, there are other reasons why firms engage in patenting. This ranges from improving their reputation – through the additional valuation from intangible assets – to conferring them with a bargaining power to better negotiate transactions around an invention. Results from a large sample of European SMEs at the EPO[1] show that, while traditional motives remain important (exclusive rights and protection from imitation), half of surveyed SMEs used the patent grant for subsequent transactional purposes with other firms like commercial contracts and licensing agreements. By allowing such forms of cooperation, licensing and other commercial agreements can be considered as a channel through which new technologies can spread across firms[2]. That said, information about licences are disclosed on a voluntary basis by EPO applicants, and the availability of data on licensing therefore remains scarce. Empirical studies are less frequently mentioned in the literature[3] and usually relies on surveys. The OECD further reports wide cross-industry differences in the use of licensing[4].

That said, not all licensing or other types of transactions necessarily involve a patent in the first place. The holding of a patent does actually *facilitate* licensing deals by protecting buyers against the expropriation of their invention, but a technology can be licensed without necessarily being protected by a patent: de Rassenfosse *et al.* (2016) estimate that about 20 % of technology transaction negotiations in Australia do not involve any patents. There is a large spectrum of IP tools used by companies, sometimes backing up one another: franchises, designs, trademarks, copyright, chips, secrecy arrangements, pools of patents, etc.

This goes without saying, well-functioning markets are an essential prerequisite for technology transactions to yield their largest expected welfare gains. However, potential imperfections may stem from information asymmetries generated by the complexity of patent filing processes and overlapping technologies in new fields of innovation, but also from strategic behaviour of firms towards patents. As observed in the first section of this article, patents have surged over the past decades in the European market[5]. This "patent boom" could certainly be associated with greater inventiveness, or the development of patent-intensive industries. But many other many factors can also explain it[6], such as the emergence of new innovative countries (e.g. China, South Korea), new disruptive technologies, the arrival of new actors like universities, the internationalisation of innovative firms which are increasingly targeting global markets and have a higher tendency to seek protection in key markets. But this patent surge could also reflect companies' strategies, not only through open innovation collaborations, but also through the take-up of 'defensive' approaches, where patents are used to secure incumbents' positions while leaving enough room to develop new technologies, and eventually of 'offensive' ones, where they intentionally and fully prevent their competitors from developing their inventions. Such strategic patenting is believed to substantially affect patent systems because it simultaneously leads to more patent filings and lower-quality applications: firms apply for more patents for a given invention or have a higher propensity to patent inventions of a lower quality[7].

1 The surveyed SMEs were interviewed in the first half of 2019. See European Patent Office (2019).
2 According to Shapiro (1985), there are three channels of technology diffusion: patent licensing, research joint ventures and imitation.
3 de Rassenfosse G. *et al.* (2017) refer to several of them.
4 The study dates to 2004 (OECD (2004). Pharmaceutical companies reported more largely inward than outward licensing and relatively low levels of cross-licensing compared to the other sectors, a possible reflection of large multinationals acquiring technologies from smaller start-ups. By contrast, the ICT sectors were found to be a heavier user of cross-licensing, maybe signaling the importance of technology sharing in this industry.
5 The WIPO also reports it to be the be the case at the USPTO and other offices worldwide.
6 See Guellec D. and B. van Pottelsberghe de la Potterie (2007).
7 See Danguy J. *et al* (2014); van Zeebroeck N. and B. van Pottelsberghe de la Potterie (2011).

Some of these practices, such as patent thickets[1] and patent trolls[2] are more concerning because of their possible detrimental effects on innovation and knowledge dissemination. Going back to the initial starting point of this article – the overall slowdown in productivity growth somewhat connected to a lack of technology diffusion – such practices deem attention and further research. A level playing field should be guaranteed to avoid an ever-growing gap ultimately stopping competitors leapfrogging the technology leaders.

1 According to Shapiro (2001), a "patent thicket" is "a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology. With cumulative innovation and multiple blocking patents, stronger patent rights can have the perverse effect of stifling, not encouraging, innovation".
2 "Patent trolls" are patent owners (often investors who buy patents cheaply from failed companies) who use these rights to threaten companies with infringement actions and interlocutory injunctions, forcing them into financial settlements to avoid expensive litigation.

(which includes pharmaceuticals according to the OECD nomenclature), reflecting the importance of multinationals in that field.

3. Patents and productivity

Returning to the initial question that underpinned the exploration of Belgium's innovative capacities, i.e. their connection with productivity growth, this section tentatively proposes a description of how patents and productivity growth unfolded. Beyond doubt, the link between the two variables is highly complex, and multiple channels are affecting the dynamics and the causality underlying their interactions. Originally, R&D expenditure lead to more economic growth (following the endogenous growth theory); patents are only one part of R&D efforts since they constitute one of the legal steps in the overall process associated with innovation. Still, they can also give some indication of a certain research productivity. An interesting starting point and tentative hypothesis stems from a part of the literature according to which patents and stronger protection were found to have a significant impact on firm-level productivity and market value (Bloom N. and J. Van Reenen (2002), Park W. (1999)[1]). Yet, Bloom N. *et al.* (2020) further show that research effort has risen substantially, while research productivity has sharply declined. This testifies that the relationship is far from being a simple one.

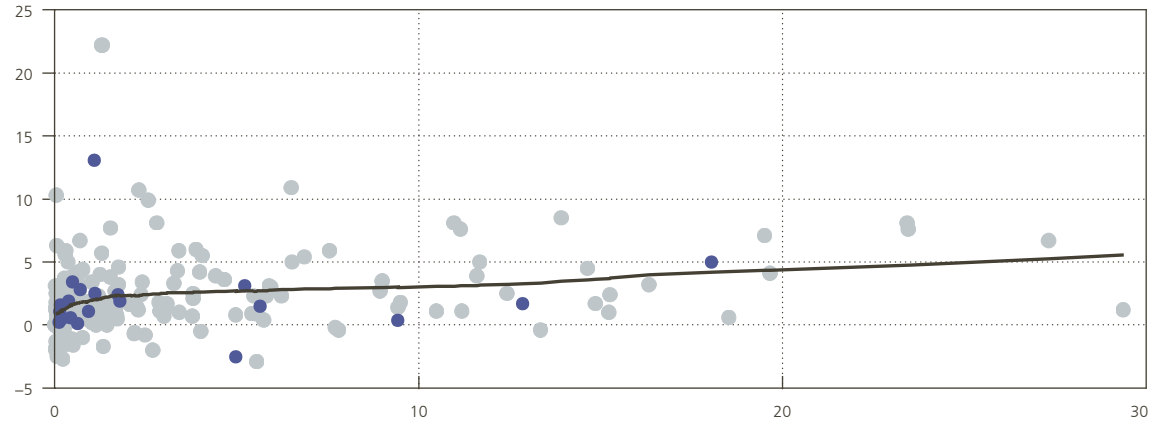
In this section, in a purely descriptive exercise, we look at the development of patents and productivity growth at the sectoral level in the case of Belgium and in other EU countries. The figures for patents are identical to those previously analysed, classified into their associated NACE code[2] and normalised by the number of people employed. Productivity growth is defined as the growth in the ratio of real value added over the number of people employed in each NACE sector. We considered the average number of patents produced in Belgium during an initial five-year period (2000-2005), against the subsequent average productivity growth over the longer-term period 2006-2016 in sectors associated with technological fields for which patents had been reported. Patents – as a downstream indicator of innovation, capturing the successful and commercially viable R&D efforts involved – could feed into productivity growth through various channels: a direct one, where the stock of innovations available to an economy is fostered thanks to the production of new technologies; and

1 For the latter, it is somewhat mitigated by the findings in de Saint-Georges M. and B. van Pottelsberghe de la Potterie (2013).
2 One should note that patents can be assigned to several technology classes at the same time.

Chart 8

Patents and productivity growth in Belgium and in a selection of EU countries[1]

(x-axis: number of patents divided by employment (average, 2000-2005); y-axis: % productivity growth (average yearly growth rates, 2006-2016))



Sources: Eurostat, EPO (PATSTAT).

1 Belgium is in blue. The other countries in grey are Germany, France, the Netherlands, Denmark, Finland, Sweden, Spain, Italy, Austria, the United Kingdom.

more indirect ones, where, thanks to the disclosure of the information relating to the inventions, the other non-patenting firms that are active in the same sector end up adopting and benefiting from the new product or process invented, yielding overall gains for the sector at large. The latter channel could relate to a form of technology diffusion. Lags in both direct and indirect adoption of new technologies justify the proposed approach, which is to observe whether any innovation through patents would turn into future productivity gains.

The scatter plot has several upshots. First of all, it shows a large cluster composed of many sectors characterised by a low average number of patents (in 2000-2005), further associated with low average productivity growth (in 2006-2016). Within this group of industries, there is wide heterogeneity: for instance, in Belgium, while initially recording a low number of patents, the basic and fabricated metals sectors generate more productivity gains than manufacturing of motor vehicles, trailers and semi-trailers, or computer programming, consultancy, and information service activities. Secondly, in Belgium, the pharmaceuticals sector and the electronic and optical products sector stand out with a higher number of patents produced over the initial period considered – another reflection of Belgian sectoral specialisation in patents. These sectors tend to be subsequently associated with somewhat higher productivity gains. Overall, the slope of the trend associated with the scatter plot is slightly positive: it hints at the fact that, possibly, positive effects of patents translate into productivity gains through technology adoption within the sector is an assumption that should not be ruled out. We insist on the fact that this finding does not allow to draw definitive conclusions; rather we view it as a starting point to initiate in-depth research to further deepen the (*a priori* positive) association found, through a solid empirical evidence highlighting the mechanisms and dynamics at play.

This goes without saying, but caution is called for with the results yielded from this approach. First, while IP strategies and patent filings differ across firms, especially in terms of their size, they also vary widely across industries. As section 2.3. points out, there is a large variation in the propensity to patent across sectors, which is ultimately reflected in a greater or lesser number of patents per (NACE) sector in our analysis: Danguy J. *et al.* (2014) show that the sectoral discrepancies in patent applications partly reflect the variations in the appropriability and in the filing strategies adopted by firms. Secondly, the sectoral productivity growth observed can be influenced by many different determinants, such as the sectoral specialisation of patents, as well

as the period under consideration[1] or competition issues relating to how concentrated sectors are. Thirdly, it is necessary to bear in mind that, on the patents side, the NACE codes are associated with the IPC sectors reported in patent documents, not systematically with the companies producing the patent[2]. In the same spirit, dividing the number of patents by the number of employed persons in each sector is a welcome step meant to normalise the sectoral patent volume by its underlying labour force. However, relying on the whole population of persons employed per sector is an imperfect metric since it is not the precise representation of the labour force associated with those firms that actually produced the patents. In further research, preference should be given to working with employment and, more generally, economic data at the level of the patenting firm[3]. Finally, next to linking patent data to firm-level economic statistics, exploiting data on firms' licence agreements would soundly back up the analysis of technology diffusion and productivity growth.

Concluding remarks

This paper seeks to understand how the innovative fabric of Belgium has developed and specialised over the last decades, through the lens of rich patent data. The justification for this assessment is to initiate an analysis of its potential relationship with productivity growth. The debate approached in this article confirms that innovation remains a core lever of productivity and economic growth. The importance of innovation and advanced research has been even more strongly emphasised with the COVID-19 crisis. Amongst other sectors also involved, massive research efforts in pharmaceuticals intended for health and therapeutic treatments to keep outbreaks of epidemics in check will prove central to developing new vaccines and quick testing tools. Therefore, and beyond the need to revive productivity growth, innovation is in the current context also closely interlinked with critical public health matters of the uttermost importance.

We first sketch a context by looking at European patents, which have grown in number over the last two decades. Since the sovereign debt crisis, Europe has confirmed its position as a strategic and attractive marketplace for innovation. When considering an overall ranking of all countries seeking to protect their innovations in the European market, applicants of European origin remain the main players, followed by the United States and Japan. Other Asian economies have successfully managed to rapidly penetrate the market, at the same time as the importance of some historical stakeholders has waned.

Belgium has managed to maintain a stable and relatively well-placed position over time. Its rank has even slightly improved if the size of the country is taken into consideration. That said, Belgium's neighbours or the Scandinavian countries still have a clear lead. Changing innovative dynamics and trends has revealed a surge of digital technologies (encompassing both digital communications and computer technologies at large), albeit with large cross-country differences. They tend to be in the hands of a concentrated pool of players and countries – with China and other Asian economies offensively involved in massive volumes of patent filings in the European market. Besides digital, patents in new medical technologies are quickly developing with promising fields in new medical devices. Patents in the sectors of energy and transport are also expanding through innovation in clean and sustainable transitions. By contrast, sectors like chemicals and pharmaceuticals remain amongst the

1 Notably, the period covering the average productivity growth (2006-2016) contains two crisis episodes – the 2008-2009 economic and financial crisis and the 2010-2012 sovereign debt crisis.

2 Data on patents were extracted from PATSTAT. Each patent document reports one or more IPC (or CPC) sector(s). These were translated into NACE codes following the concordance table between the IPC and NACE nomenclatures directly available in PATSTAT as developed by Schmoch U. *et al.* (2003). This concordance scheme has been elaborated and validated by matching IPC sub-classes to industries via an assessment of a representative sample of firm-owned patents. However, it should be noted that the conversion of IPC codes to NACE classes may not systematically be linked to the primary activity of the applicants, so sectors tend to reflect the particular patent technologies.

3 To do that, the names of patent applicants should first be harmonised and correctly linked to the other sets of databases of economic performance statistics at the firm-level. This matching involves several steps and in-depth work, which goes beyond the frame of this descriptive article. See Thoma G. and S. Torrisi (2007), the OECD work on the OECD HAN database and Lissoni F. *et al.* (2008) for an application of the matching of the inventor–professor from the KEINS database on academic inventors.

top innovative fields but seem to be maturing: more recently, they have shown a more subdued growth pace, while other fields have bloomed.

Secondly, we focus more particularly on Belgium and distinguish some of its typical key features by comparing it to a group of reference countries. There are several principal messages. There seems to be a persistence over time for Belgium to specialise in more mature technologies, with the top three patenting fields relating to other special machines, biotechnology and pharmaceuticals. These do not coincide with the fastest developing fields of innovation in the overall European market, and worryingly Belgium seems to be left out from the flourishing patch of digital innovations and other fast-growing fields without any clear sign of reallocation towards these breakthrough technologies.

That said, such a disadvantage is not irremediable: an optimistic stance is that the integration of digital applications (made possible by AI advances, for instance) into physical sectors characterising in part the patent specialisation in Belgium can broaden the opportunities for cross-fertilisation especially since boundaries between the use of technologies are becoming increasingly blurred (e.g. medical devices, implants and bionics made through 3D printing, autonomous vehicles integrating AI technologies). This opens the way for new opportunities offered to Belgian applicants to better position themselves by tweaking their relative advantage with the developing disruptive technologies. Moreover, one of the strengths found is the favourable positioning in pharmaceuticals. Belgium can be expected to be an important player in those fields in the future, as its strategic involvement in the development of new vaccines against COVID-19 has demonstrated. On top of that, the opportunities surrounding green technologies should be exploited in future research.

When considering the most important patent owners amongst Belgian residents, there is a high degree of concentration. Patents are determined by a few and/or large entities active in a handful of key sectors (e.g. chemicals, pharmaceuticals and biotech industries): broadly speaking, almost 40 % of Belgian patents filed at the EPO are concentrated in the hands of the top ten Belgian players. Some of them are co-owned by foreign entities following their mergers and acquisitions history; some have established laboratories abroad or are involved in collaboration projects with inventors located in other countries. This concentrated nature of patents brings some vulnerability, by being reliant on a few actors (domestically as well as internationally) and sectors upon which the whole patenting activity hinges. Retracing the full ownership structure of firms and their affiliates would help identify the exact connections between entities and provide a more comprehensive picture of how concentrated patenting activity in Belgium really is and the likely impact from internationalisation strategies.

Belgium tends to be highly involved in international collaborations in patents. Whatever form it takes, being highly integrated into global research networks is likely to encourage technology diffusion benefiting a small open country. Without necessarily being the sole producer of patents, Belgium contributes to developing advanced technologies and gains from foreign spillovers of such collaborations. It also mirrors recognition of the skills and value of Belgian inventiveness, as well as the attraction of Belgian researchers for foreign corporations seeking to work with them. What will be crucial is remaining closely involved in high-value technological innovations and being able to move up the ladder as new ones emerge (e.g. green tech, health medication and vaccines against COVID-19).

The focus on cross-border ownership of patents further highlights the 'mixed' form of patent ownership followed in Belgium, where the country owns numerous patents abroad, but its patents are even more closely controlled by international entities. Experience from other EU countries supports the fact that the more a country is involved in research and innovation, the more it tends to exert a form of control over it. In addition, the role of education makes a substantial contribution to providing enough capacity to absorb and use the new knowledge acquired, thanks to the availability of an adequately qualified labour workforce. Belgium's position highlights that knowledge created by Belgian inventors, wherever they operate, is certainly well recognised and very much in demand, but it basically flows out towards their external owners, with Belgium losing its grip on the full benefits of returns on patents and innovation. Upstream, this calls for revamping education policies to

enable better assimilation of the new skills related to emerging and fast-developing technologies (e.g. digital technologies where Belgium seems to be lacking in STEM skills).

Another key Belgian feature is the very active role of universities, which have become major patenting actors. Some are working together, showing that inter-university collaboration and clusters are successful in delivering new technologies. Belgian universities are a good showcase for the quality of researchers and the country's underlying inventive fabric. For future research, the involvement of universities in patenting could be further approached by analysing connections with companies. On the flipside, the importance of universities in Belgian patents could be a symptom of the relative weakness of business and SMEs in spawning innovation. It would be worth investigating the possible influence of the lack of business dynamism in Belgium.

The last section described how patents and subsequent productivity growth across sectors have evolved together, considering Belgium and other European countries. The link between the two variables is undoubtedly highly complex and caution is needed with this approach. But overall, this descriptive exercise suggests that the assumption of positive effects of patents translating into productivity gains should not be ruled out. This is a starting point for further deepening of the (*a priori* positive) association found and better understanding of the mechanisms and dynamics effectively at play.

Annexes

Annex 1 – Patents: main definitions and features of the associated processes

- Definition of a patent

According to the OECD (2009), "a patent is an intellectual property right issued by authorized bodies which gives its owner the legal right to prevent others from using, manufacturing, selling, importing, etc., in the country or countries concerned, for up to 20 years from the filing date. Patents are granted to firms, individuals or other entities as long as the invention satisfies the conditions for patentability: novelty, non-obviousness and industrial applicability".

In addition to the above-mentioned protection, WIPO (2015) adds that "the publication of a patent and in many countries patent applications give the public access to information regarding new technologies in order to stimulate innovation and contribute to economic growth".

Within the document accompanying each patent application, useful information can be found, such as the number and type of application, publication number, etc; the name and address of the inventor; the name and address of the applicant (usually the company employing the inventor); technical details regarding the invention (title, abstract, detailed description of the invention, how it is constructed, how it is used and what benefits it brings compared with what already exists); a list of claims (the clear and concise definition of what the patent legally protects); the codes corresponding to items in a technology classification; a series of dates (date of priority, application, grant, etc.) and a list of references to other patents or scientific literature considered as relevant to the determination of patentability of the invention.

- Possible routes of patents and offices

Following the OECD (2009) and WIPO (2015), a patent application may be filed via one of the following routes:

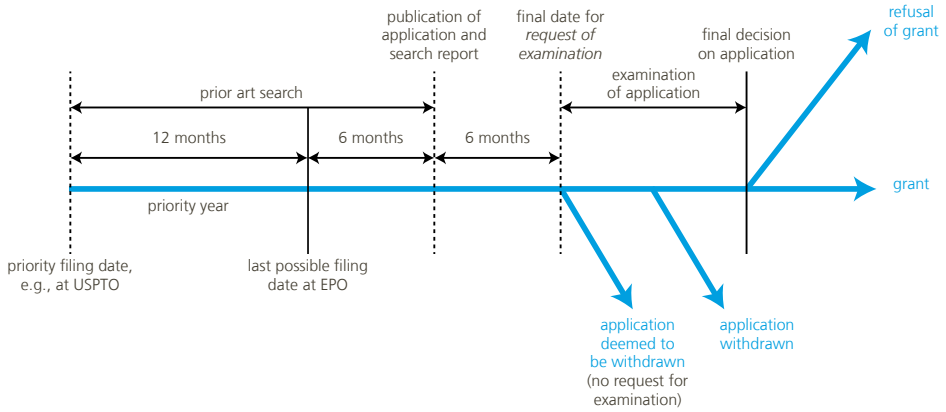
- **National**: when an inventor (an individual, company, public body, university, non-profit organisation) decides to protect an invention, the first step is to file an application with a national patent office – generally the national office of the applicant's country. After examination, the patent for an invention may be granted and enforced only in the country in which patent protection is requested in accordance with the law of that country. Corresponding applications covering the same invention can be filed in accordance with the respective national patent laws in different countries on an individual country-by-country basis.

- **Regional**: patent applications may (also) be filed at a regional patent office, for example the European Patent Office (EPO). Regional patent applications have the same effect as applications filed in the member states of the respective regional patent agreement. In certain regions, patents are granted centrally as a 'bundle' of national patents. In other regions, a single regional patent granted by the regional patent office has effect in the entire territory of that region. In order to validate regional patents in the EU Member States, provision of a translation of the granted patent into the national language may be required; this is for instance the case at the EPO (see also further).

- **International**: international applications may be filed with the national or certain regional patent offices of the contracting states of the Patent Cooperation Treaty (PCT), or directly at the international bureau of the World Intellectual Property Organization (WIPO) by any resident or national of a PCT contracting state. A single international patent application has the same effect as national or certain regional applications filed in each contracting state of the PCT. Although the major part of the patent application procedure is carried out within the international phase, a patent can only be granted by each designated state within the subsequent national phase.

Chart 9

Timeline of a typical patent from the national examination phase to the eventually enlarged regional protection



Source: Harhoff and Wagner (2005).

In the case of a patent in Belgium, the whole examination process may take from six months (national) to six years (regional/European) before it is granted.

- European patents: direct EPO and Euro-PCT applications

According to the OECD (2009), European patents can be obtained for all countries of the European Patent Convention by filing a single application at the EPO in one of the three official languages (English, French or German). European patents granted by the EPO have the same legal rights and are subject to the same conditions as national patents (granted by the national patent office). It is important to note that a granted European patent is a "bundle" of national patents, which must be additionally validated at the national patent office in order to be effective in member countries. The validation process may include the submission of a translation of the specification, payment of fees and other formalities required by the national patent office (once a European patent is granted, the competence is transferred to the national patent offices), which can end up being very costly depending on the number of countries where the patent proprietor wishes to validate the European patent.

Concerning the EPO, it is worth noting that it was created as to grant European patents based on a centralized examination procedure. It is not, however, an institution of the European Union. There is still at present no single grant of an EU-wide patent. However, recent legal steps were taken to establishing a "Unitary Patent System"[1] which provides a uniform patent protection in up to 25 EU Member States by submitting a single request to the EPO, for both the application procedure and the legal enforcement after grant. Its perks are that it would not only reduce the cost of patenting in Europe, it would also make the system more attractive[2]. The start of the new system is currently expected for the beginning of 2022.

1 Two EU Regulations provide the legal framework for the Unitary Patent system: i) EU Regulation No. 1257/2012 (OJ EPO 2013, 111) creates a "European patent with unitary effect", commonly referred to as "Unitary Patent"; and ii) EU Regulation No. 1260/2012 (OJ EPO 2013, 132) lays down the translation arrangements for Unitary Patents.

2 See Danguy J. and B. van Pottelsberghe (2011).

Next to direct filings of patents at the EPO, an international application for which the EPO is a designated office and which has been accorded an international filing date has, as from that date, the effect of a regular European application (Euro-direct application). Such international application, being equivalent to a regular European patent application, is referred to as "Euro-PCT application".

- Reference dates

Broadly speaking, there are four main reference dates (and for each, a corresponding patent document). An inventor seeking protection first files an application generally in his/her country of residence: this very first date refers to the 'priority date'. Then, he/she has a 12-month legal delay for eventually applying for protection of the original invention in other countries, referring to the 'application date'. The application is then published at least 18 months after the 'priority date', at the 'publication' date. Finally, it can take three to ten years for a patent to be granted ('granted date').

- Reference country

Patent documents include information distinguishing between the inventor's and the applicant's country:

- Patents following the *inventor's country* of residence indicate the inventiveness of the local labour force, laboratories and research facilities of a country. Opting for it helps give a better picture of a country's inventive performance.

- Patents following the *applicant's country* of residence refer to the ownership of an invention, regardless of where research facilities are actually located.

- Simple vs fractional counts of patents

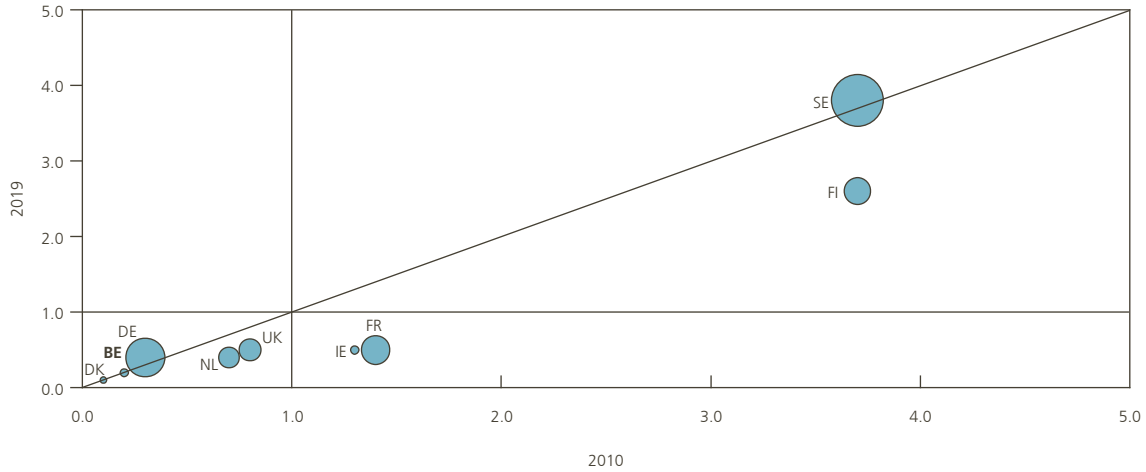
For a unique patent, many different applicants (or owners), as well as multiple inventors located in different countries, may be involved, so an alternative counting approach to the simple count of patents can be used.

Fractional counts enable multiple counts of the same patent to be avoided and better reflect the 'real' contribution of each country to a given patent. When applying a fractional count to patents, figures in absolute numbers may drop slightly which is consistent with its inherent calculation. If one application has more than one inventor, the application is divided equally amongst all of them and their corresponding country of residence (fractional counting), thus avoiding double counting.

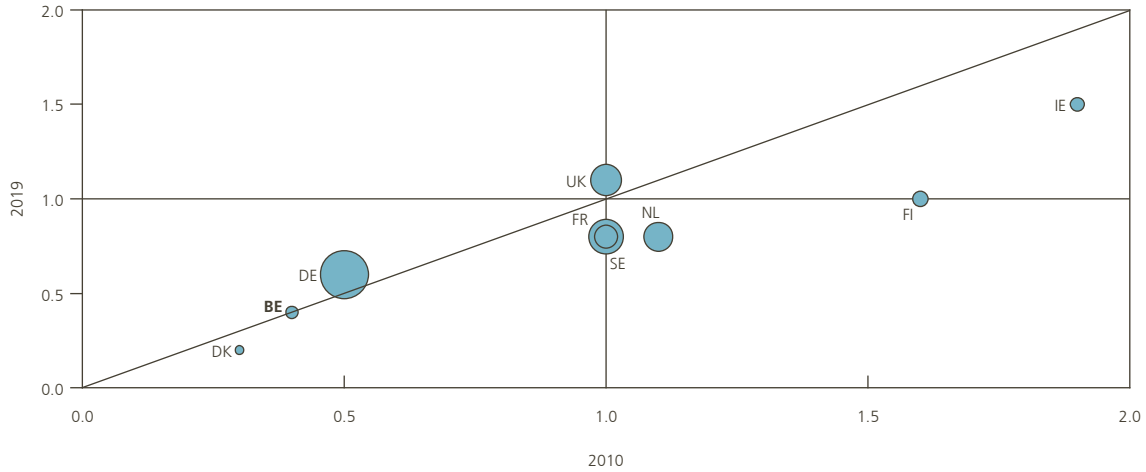
Annex 2 – Revealed Technology Advantage of patents of the top ten fields and environmental technologies of all countries at the EPO[1]

(2010 on the x-axis, 2019 on the y-axis, direct and Euro-PCT applications)

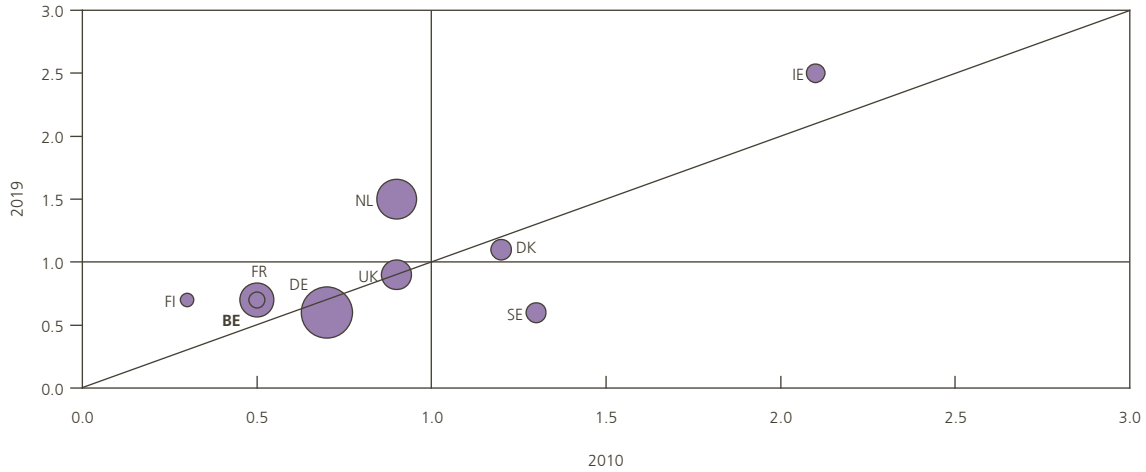
Digital communication



Computer technology

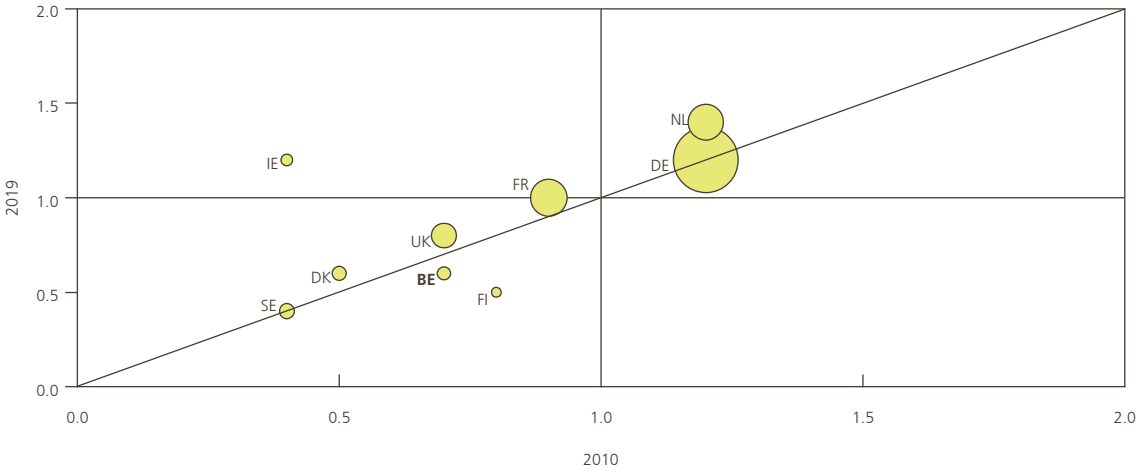


Medical technology

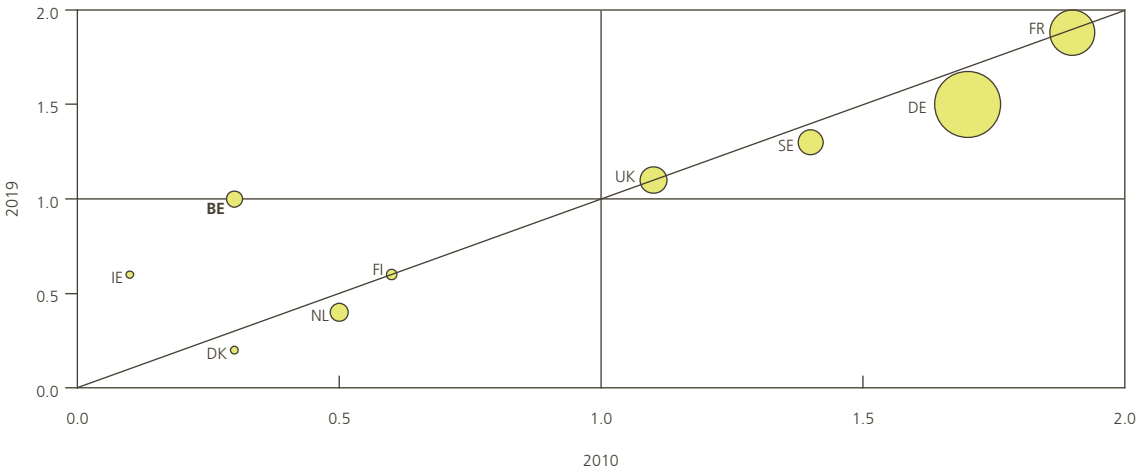


1 The size of the bubbles is proportional to the absolute number of patents of the country in the field of technology considered. An index above 1 signals a specialisation of patents in the sector considered (the higher, the more specialisation is reported). Countries above (below) the 45-degree line have reinforced (reduced) their specialisation in the technology field between 2010 and 2019.

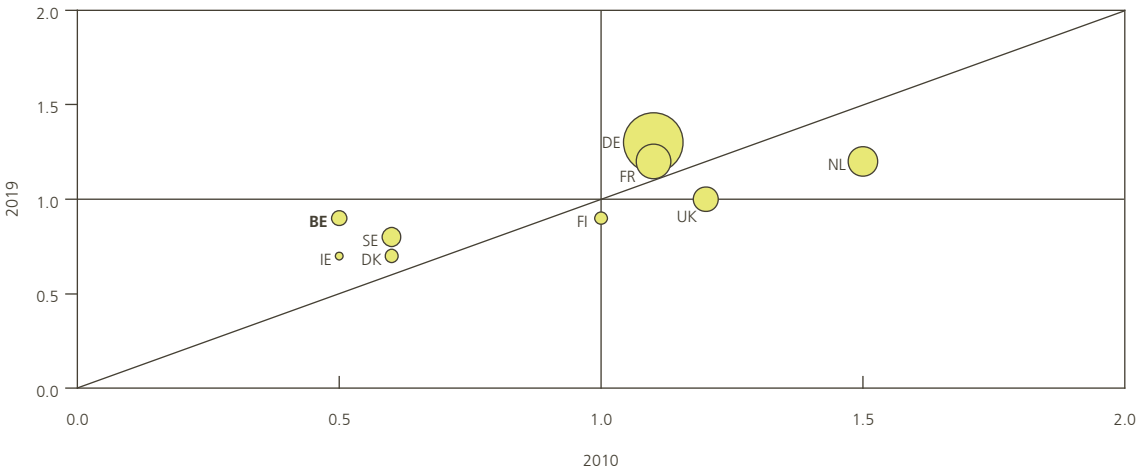
Electrical machinery



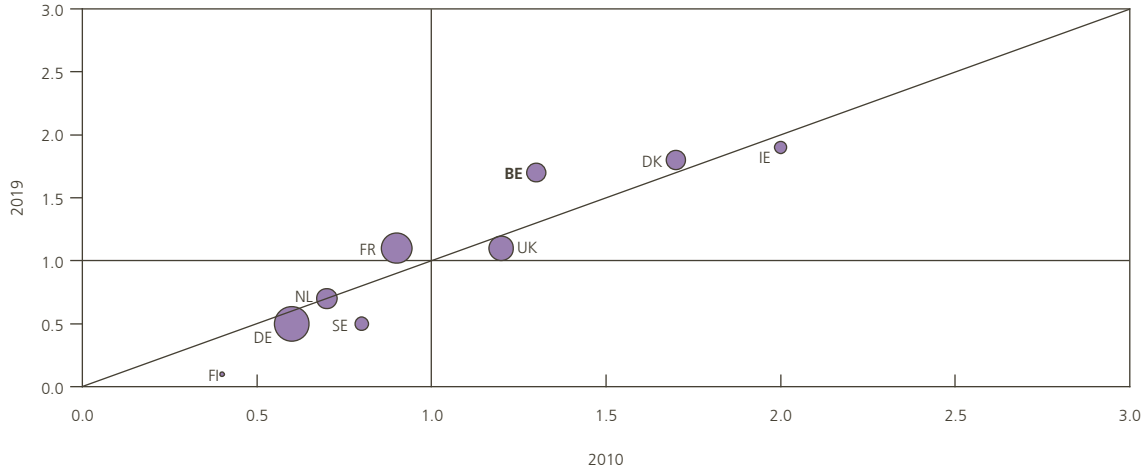
Transport



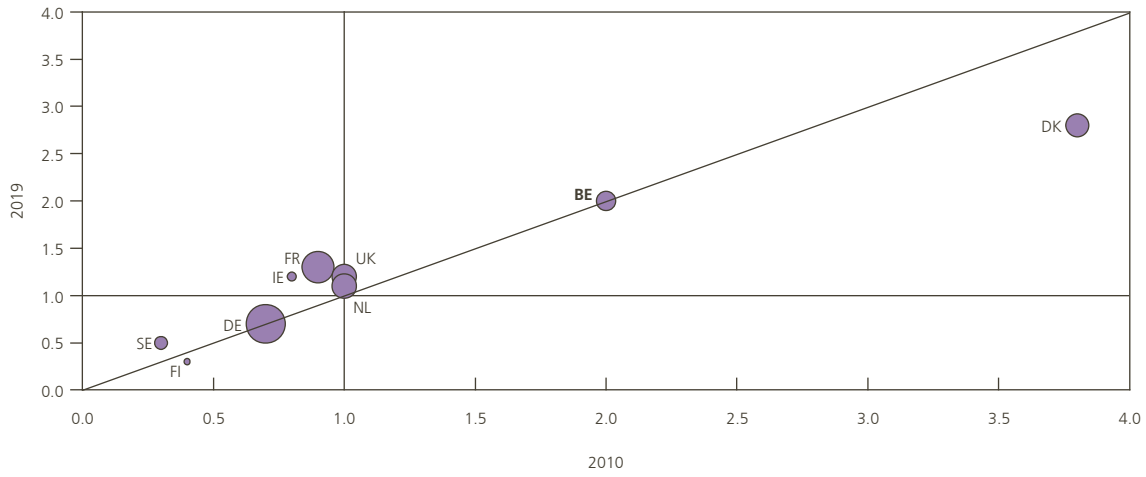
Measurement



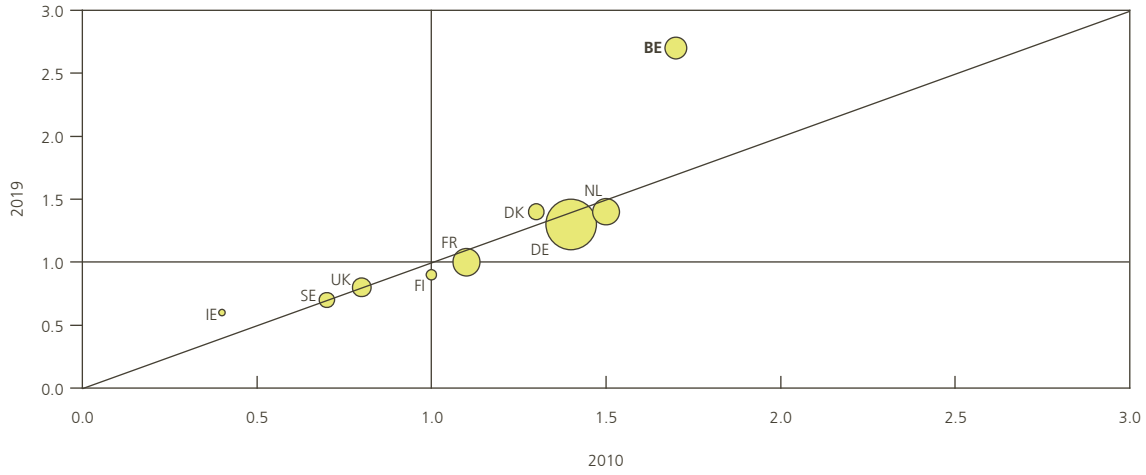
Pharmaceuticals



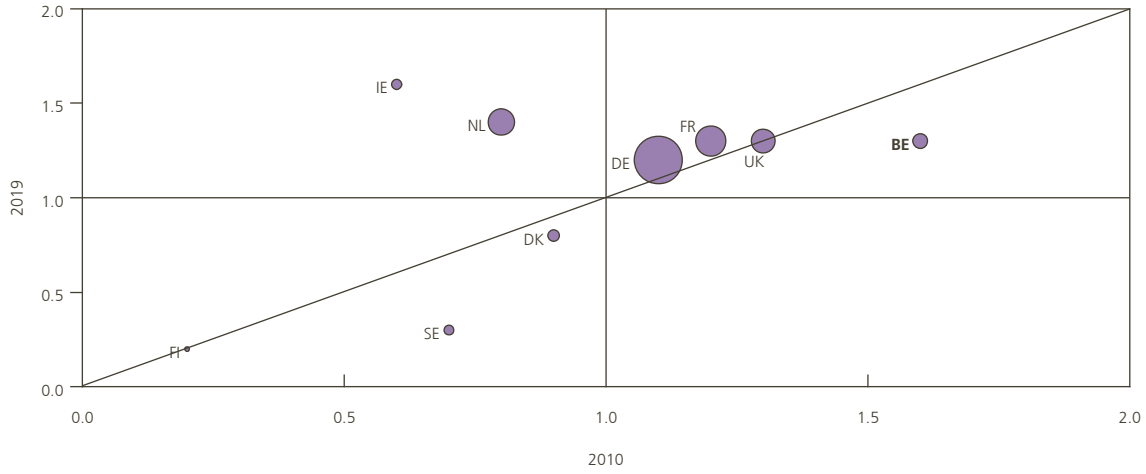
Biotechnology



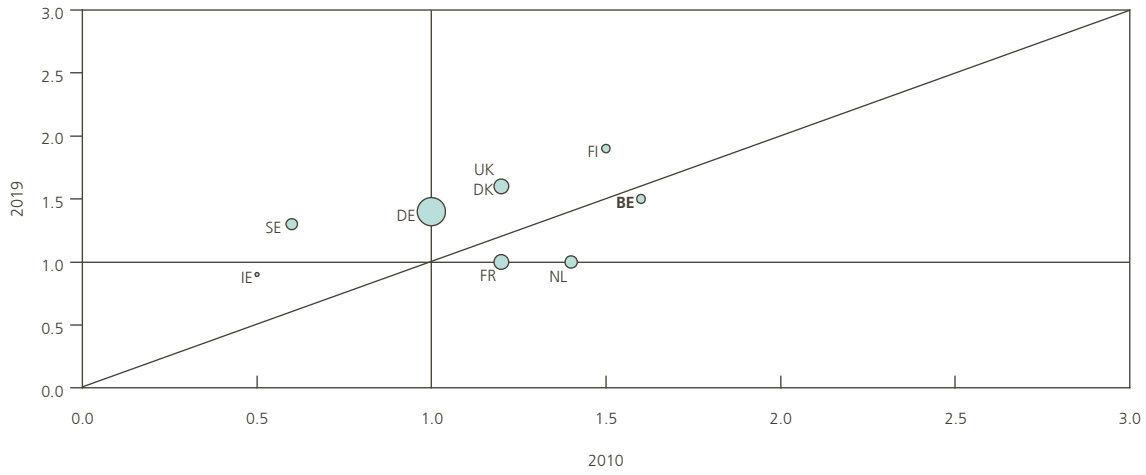
Other special machines



Organic fine chemistry



Environmental technology



Source: EPO.

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Belgium's fiscal framework: what is good and what could be better?

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P. Stinglhamber
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Introduction

During the COVID-19 crisis, a strong fiscal stimulus has provided support for economic activity and ensured that it could subsequently begin to recover. The corollary to that is a steep rise in budget deficits and the public debt, which will have to be reversed in the aftermath of the crisis. This makes fiscal policy more prominent as a crucial element of macroeconomic policy aimed at promoting stability and growth. Well-designed fiscal frameworks can make a significant contribution here. In this respect, the European fiscal framework will be supported by national fiscal frameworks comprising a set of strong and efficient national budgetary procedures, fiscal rules and fiscal institutions forming the basis of the conduct of fiscal policy.

This article focuses on the most important aspects of the Belgian fiscal framework. On the basis of a description of how the framework operates and an analysis of best practices in other euro area countries, it will examine which aspects work well and which could be improved. Among other things, the article uses data from a survey conducted at the beginning of 2020 by the ESCB Working Group on Public Finance (WGPF), covering the national central banks of the 27 EU countries by detailed questionnaires concerning their national fiscal frameworks. Some suggestions for improving the Belgian fiscal framework will then be made.

This article is structured as follows. The first part defines the concept of a national fiscal framework, sets out the arguments put forward in the literature in favour of introducing such a framework, and explains the connection with the European fiscal framework. The second part examines in more detail an essential aspect of the national fiscal frameworks, namely budgetary procedures. It will consider the macroeconomic framework, followed by the revenue estimate, budget monitoring and control, the medium-term framework and some new developments. The third part looks at a second aspect of the national fiscal frameworks, namely the national fiscal rules. The next part describes the role that independent fiscal institutions perform within the fiscal framework. Here, the focus will be on the role of the High Council of Finance "Public Sector Borrowing Requirement" section. The fifth

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part examines the necessary budgetary coordination between the various echelons of the Belgian government. The concluding part sums up the main findings.

1. National fiscal frameworks

1.1 Description of national fiscal frameworks

A national fiscal framework is generally defined as the set of provisions, procedures, rules and institutions underlying the conduct of fiscal policy. There are five important components:

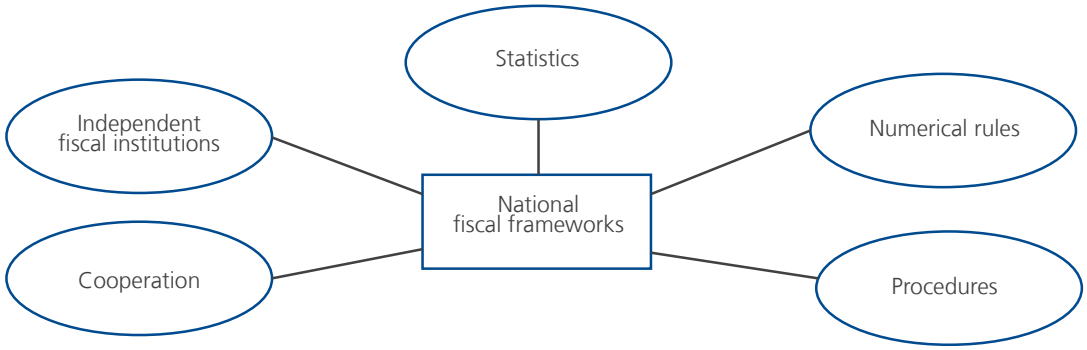
- systems for reliable, prompt and detailed statistical reporting on developments in public finances;
- numerical rules setting targets for key fiscal aggregates;
- procedures for producing forecasts for budgetary planning, monitoring the execution of the budget, and medium-term planning;
- mechanisms and rules regulating budgetary relationships between the various echelons of government;
- independent institutions offering fiscal policy recommendations and assessments.

These various components are interdependent and complementary, and determine the operation of the national fiscal framework. For example, strong fiscal rules and well-designed budgetary procedures will reinforce one another. As a further example, efficient, independent fiscal institutions foster compliance with the fiscal rules.

This article will not discuss fiscal statistics since there is in general no problem in Belgium with the availability of prompt, reliable government statistics. The financing balance of the government sector as well as other variables of the government accounts according to the ESA methodology are central aggregates for fiscal policy. Since the start of the Stability and Growth Pact, in the second half of the 1990s, Eurostat has kept a close eye on the production and quality of these figures. It does so on the basis of guidelines and periodic audits. The requirements for the figures were gradually strengthened. For instance, following the financial and economic crisis a rule was introduced requiring the publication of more short-term data, and Eurostat's auditing powers were extended, and financial sanctions were introduced for countries which falsify their figures.

Chart 1

Main components of a national fiscal framework



Sources: EC, NBB.

The success of a national fiscal framework depends on its quality and the coherence of its parts, but its implementation is also crucial. Strong political commitment to fiscal discipline and a social consensus in that regard are vitally important here.

1.2 The benefits of effective national fiscal frameworks

It is generally agreed that effective national fiscal frameworks can make a substantial contribution towards conducting fiscal policy. They enhance government efficiency and the transparency of decision-making. That is obvious for some aspects, such as the prompt availability of reliable, detailed fiscal statistics, cooperation between public authorities, or medium-term planning. But other aspects such as the existence of numerical fiscal rules or independent institutions responsible for macroeconomic and fiscal forecasts or fiscal policy recommendations and assessments, can also make a significant contribution to good budgetary results, as they can combat the so-called "deficit bias", the tendency to conduct procyclical fiscal policies and the risk of a lack of fiscal discipline in a monetary union.

The deficit bias means that the democratic decision-making process may provide incentives for governments to allow too high – or even excessive – deficit and debt levels, deviating from what might be considered the best fiscal policy from a macroeconomic viewpoint.

One reason for the deficit bias is that the population and politicians consider too short a timescale. For instance, individuals focus mainly on the short-term advantages of lower taxes or higher spending, without always being aware of the potential, adverse longer-term impact on the budget of such an expansionary fiscal policy. Politicians could be inclined to capitalise on that in order to boost their chances of re-election. There may also be a preference for deliberately favouring the current generations and shifting the debt burden onto future generations. Another explanation for the deficit bias is offered by what game theory refers to as the common pool problem. Where fiscal policy is concerned, this means that each "player" or interest group promotes its own interests without taking account of the general budget restrictions.

Furthermore, fiscal policy is often procyclical, whereas there is a consensus that the optimum policy should be anticyclical. A procyclical policy reinforces the fluctuations in economic activity and increases the debt. Such a policy comes about because of the difficulty of estimating the economic cycle situation and outlook in real time, combined with the delay in implementing fiscal policy. In addition, there are the so-called economic policy reasons whereby policymakers attach less importance to stabilising output than to other objectives, and all kinds of pressure groups step up their demands for additional expenditure or lower taxes when the economy is doing well.

In a monetary union, there is an even greater risk of a lack of fiscal discipline. If a country does not belong to a currency area, then in principle the financial markets can discourage an inappropriate fiscal policy when setting interest rates by imposing a higher risk premium on governments facing budgetary problems. In a monetary union, this mechanism might hamper if financial markets believe that in case of serious financial difficulties of a member country, there will be some kind of bail-out. Without such a mechanism, unsustainable public finances in one member country might lead to a sudden stop in the willingness of financial markets to finance government debt with, eventually, contagion effects for the monetary union as a whole. As both situations are problematic, it is clear that sustainable public finances are an essential condition for a well-functioning currency union. This reasoning applies not only to a monetary union comprising different countries, but also to local authorities and the component entities in a federal state.

1.3 European and national fiscal frameworks

In contrast to monetary policy, the fiscal policy of the euro area countries is a national competence. However, since the start of the economic and monetary union, it has been largely determined by a European framework aimed at promoting fiscal discipline and avoiding undesirable budgetary outcomes[1].

The basis of the European fiscal framework was laid by the Maastricht Treaty and the Stability and Growth Pact, which implements the Treaty's requirements concerning fiscal supervision. The framework comprises a preventive arm, aimed at avoiding the development of unsustainable budgetary situations, and a corrective arm, relating to the recovery measures for Member States facing serious problems in their public finances. Various adjustments to the fiscal framework have made it smarter but at the same time also more complicated[2]. That complexity is regarded as problematic and has therefore prompted ongoing discussions on the reform of the European fiscal rules.

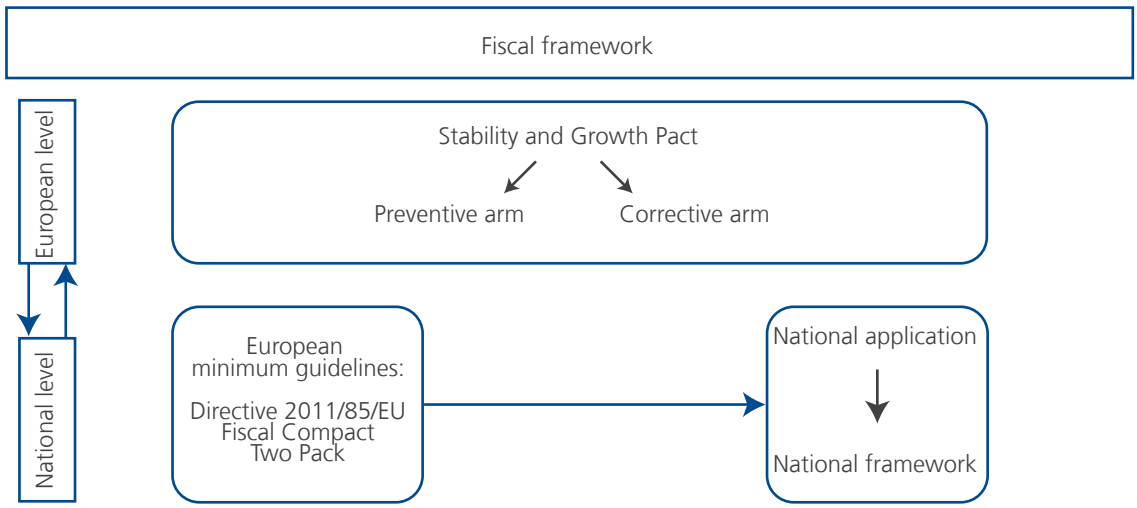
Over the years, there has been a growing conviction that the European rules need to be supported by strong, efficient national frameworks. These frameworks are seen partly as a way of creating the necessary environment for compliance with the European fiscal rules, and partly as a way of reinforcing the national ownership of those rules.

Since the creation of the euro, the national fiscal frameworks have made strong progress, in parallel with the development of the European fiscal framework. Following the financial and economic crisis of 2008-2011 in particular, in the context of the strengthening of governance at European level, there were a number of important initiatives for improving the national fiscal frameworks. This was in line with the shift towards stricter fiscal and economic supervision in response to the crisis. The EU Member States agreed on a number of requirements for their national fiscal frameworks with the aim of increasing their quality and their effectiveness in supporting fiscal discipline.

1 At present, the European fiscal framework has been temporarily suspended by the European Commission's activation of the "General Escape Clause" in March 2020.
2 The fiscal rules at EU level are dealt with here only very briefly since they have already been discussed in depth in Melyn *et al.* (2015), and have remained largely unchanged since then.

Chart 2

The European and national fiscal framework



Sources: NBB, EC.

A first initiative concerned Council Directive 2011/85/EU laying down some basic requirements for the budgetary frameworks of the Member States. That directive was adopted as part of the so-called Six Pack, the six texts setting out the new EU governance legislation, which was formally approved in November 2011 and specifies a number of minimum requirements which the Member States must meet in their national fiscal frameworks. Those minimum requirements are fairly vague, but they aim at greater consistency between the national and European rules and institutions. They concern the availability of reliable statistics for monitoring the budget, the introduction of numerical fiscal rules and associated correction mechanisms, the drafting of a detailed medium-term plan with a view to achieving the goals specified in the stability or convergence programme, the use of realistic macroeconomic and fiscal estimates, and the introduction of appropriate coordination mechanisms between all subsectors of general government.

A second initiative concerns the fiscal compact introduced at the end of 2011. This pact aimed to promote fiscal discipline and further reinforce European fiscal supervision. These agreements were laid down in a new intergovernmental "Treaty for Stability, Coordination and Governance in the Economic and Monetary Union" ("TSCG"), signed in March 2012. The fiscal compact is the budgetary section of the new treaty. Its principal stipulation is that the government budget must be in balance or in surplus. This requirement is considered to be met if the structural budget balance for the year is in line with the country-specific medium-term objective (MTO), with the proviso that any medium-term deficit target must not exceed 0.5 % of GDP. It is necessary to converge to the country-specific medium-term objective (as defined in the Stability and Growth Pact), with the EC proposing the adjustment path [1].

Thirdly, the so-called Two Pack – i.e. two legal texts proposed by the EC on 23 November 2011 and intended to further tighten up fiscal supervision for countries in the euro area – also contains a number of provisions on national fiscal frameworks. Among other things, it laid down a common budget calendar, it introduced the obligation to base budgets on independent macroeconomic estimates, and it assigned an important role to independent fiscal institutions in regard to checks on compliance with the numerical fiscal rules.

There are wide variations between Member States in the design and effectiveness of the national fiscal frameworks. The principal reason is that the EU directives only lay down minimum requirements for the national fiscal frameworks, and there are variations in the implementation of – and compliance with – national guidelines. Discrepancies have also arisen between the European and national fiscal frameworks. That has undermined the credibility of both and made them more complex. The interaction between the European and national fiscal frameworks is nevertheless crucial to the proper operation of both.

There is still scope for further reinforcement of the national fiscal frameworks and for improving the interaction with the European fiscal framework. That is clear from a study of the operation of the EU's economic and fiscal policy framework, and more specifically the Six Pack and the Two Pack, published by the EC in early 2020 (EC, 2020b). Originally, the intention was to organise a public debate in mid-2020 based on that study, in order to collect proposals for possible adjustments. On that basis, towards the end of 2020, the EC was then to put forward proposals for further adjustments to the European policy framework and for any ensuing adjustments to the national fiscal frameworks. However, that initiative was put on hold as a result of the COVID-19 crisis.

2. Budget procedures

Budget procedures encompass the procedural rules laid down by law for drawing up, implementing and monitoring the budget. These rules specify the tasks of the parties involved (government, administration,

1 In December 2017 the EC drew up a proposal for a Directive for the European Council with the intention of incorporating the fiscal compact in EU law. That Directive has not yet been approved.

parliament, independent institutions) according to a timetable. This section looks at a number of important aspects of the budget process, namely the production of macroeconomic forecasts, the estimate of public revenues, monitoring and control of the budget, multiannual planning, and a number of new developments such as the costing of election manifestos and the conduct of spending reviews.

2.1 Macroeconomic forecasts

Cautious, realistic macroeconomic and budgetary forecasts are the cornerstone of an effective national fiscal framework[1]. Governments may in fact be inclined to use over-optimistic growth estimates, because that creates more budgetary scope, enabling them to avoid difficult consolidation measures ex ante. However, such practices subsequently have repercussions on the budget balance outcome, which will logically prove to be less favourable than expected if growth actually falls short of the estimate. Governments then frequently reject responsibility for that, by blaming the less favourable outcome on bad luck, or more specifically on weaker than expected growth.

In theory, independent institutions should not be tempted to do that. Such institutions should therefore be able to counterbalance any tendency on the part of governments to put an optimistic bias on the growth estimates underlying the budgets. In these circumstances, it is thought to be a good thing that governments should be obliged to use an independent institution's growth estimates when drawing up their budget. However, in the absence of such a formal obligation, the temptation to put an optimistic slant on growth can also be curbed by the fact that the independent institution's estimates form a benchmark against which the government's estimates can be compared.

In Belgium, the macroeconomic forecasts underlying the preparation and control of the budget are drawn up by the National Accounts Institute (NAI). This is a public institution with legal personality whose work is carried out by the associated institutions, namely the Federal Planning Bureau (FPB), Statbel and the National Bank of Belgium. This collaborative relationship and the presence of representatives of the various mutually independent institutions results in shared responsibility and thus reduces the risk of exposure to political pressure. The Federal Planning Bureau draws up the Economic Budget on behalf of the NAI, estimating the main national accounts aggregates used in the preparation – and monitoring – of the budget. The FPB is a non-profit entity with legal personality. It comes under the joint authority of the Prime Minister and the Minister of Economic Affairs but carries out its work entirely independently. The responses to the WGPF survey show that there are still only three other euro area countries, namely the Netherlands, Slovenia and Austria, in which an independent institution produces the macroeconomic forecasts.

To ascertain whether the governments of a number of important euro area countries draw up their budgets on the basis of over-optimistic estimates of real GDP growth (for the next year) – the so-called optimism bias – the growth estimates for the period 2000-2019, excluding 2009, the year of the great recession, are compared with the EC's estimates. The national authorities' growth estimates are derived from their successive stability programmes over the same period. The growth estimates on which the budgets are based are compared with the EC's estimates produced at roughly the same time. The forecasts are also compared with the growth actually achieved.

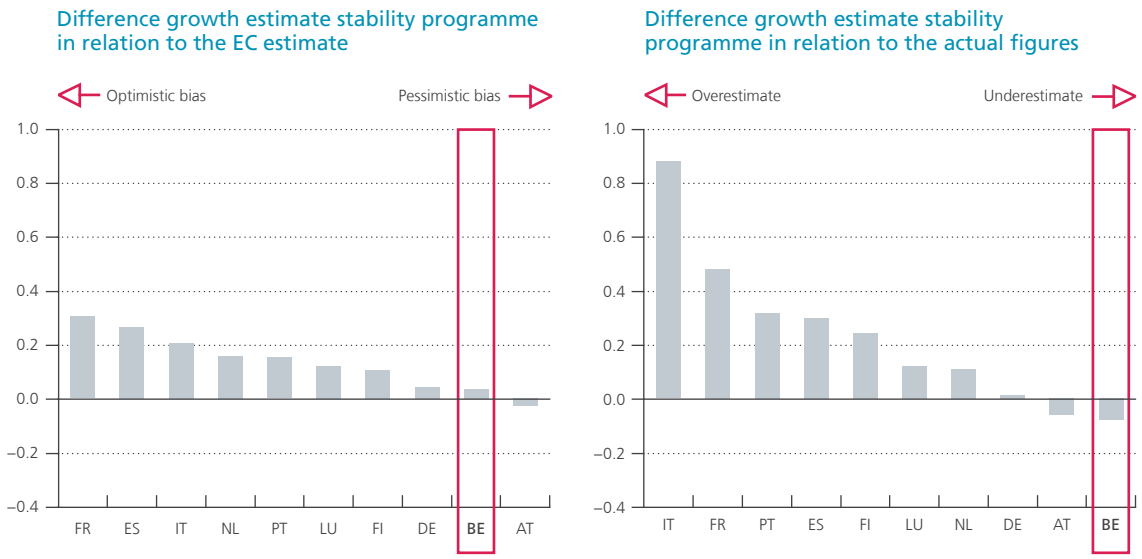
The comparison of the growth forecasts for Belgium shows that the assumptions used in the stability programmes were, on average, 0.04 pp more optimistic than the corresponding EC forecasts. There is therefore no optimism bias in Belgium's forecasts. For most of the other countries examined, the discrepancies are larger: most countries overestimate future growth compared to the EC's forecasts.

1 The aforesaid Council Directive 2011/85/EU gives a number of instructions on this subject. For instance, the Member States must base their budget forecasts on the most up-to-date information and the most likely macroeconomic and fiscal assumptions. Member States are also asked to publish their forecasts, and there are regular discussions with the EC on the assumptions used. In addition, the forecasts are subject to regular ex post evaluation. Member States must specify which institutions are responsible for the macroeconomic and budgetary forecasts. The Two Pack added some further requirements concerning the macroeconomic forecasts used to draw up the draft budget.

Chart 3

Difference between the growth estimates in the stability programmes and the EC's estimates or the actual figures for some of the most important euro area countries [1]

(difference between the average annual real GDP growth rates over the period 2000-2019, in percentage points [2])



Sources: EC, NBB.

1 Countries were chosen based on the availability of comparable data over the entire period.

2 2009 is disregarded since the unexpectedly severe economic recession in that year makes it difficult to obtain comparable figures.

Comparison of Belgium's growth forecasts with the actual growth figures shows that, on average, the actual growth was 0.08 pp higher than the forecast figures used in drawing up the stability programmes. In comparison with most of the other countries considered, this is a minor deviation. In some countries, there are very large differences between the growth assumptions used in drawing up the budget and the actual growth figures. For instance, the difference comes to 0.4 pp or more in Italy and France.

In regard to the macroeconomic forecasts, Belgium therefore does well and can even be regarded as representing an example of best practice.

2.2 Estimate of tax revenues

2.2.1 Belgium

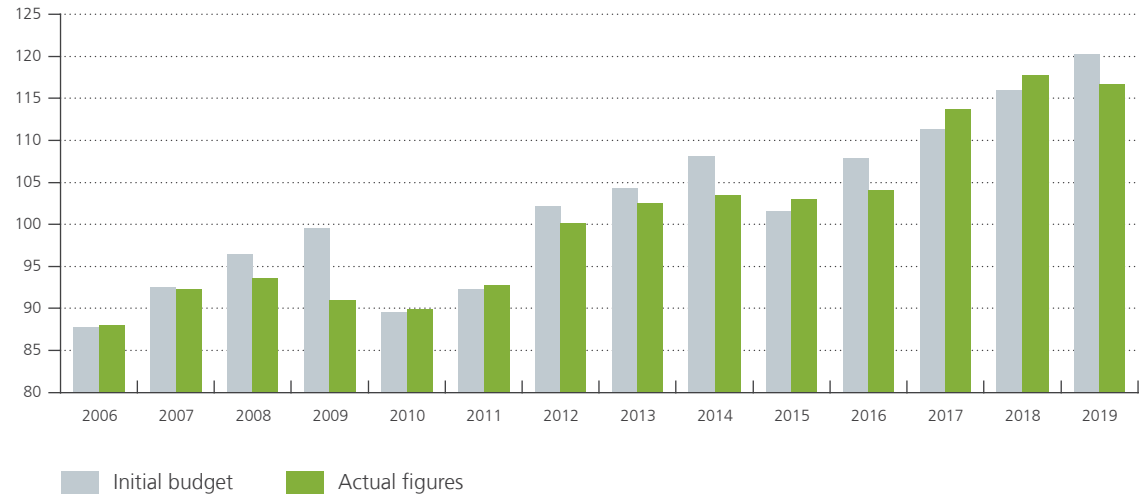
The tax revenue collected by the federal government is estimated by the Federal Public Service Finance, which produces a separate estimate for each tax rather than an overall estimate. The main tax revenue categories are estimated using the disaggregated method. This concerns the estimate of personal income tax, corporation tax, VAT and excise duties [1]. Estimates based on this method start with the presumed actual revenues for the previous year and then – on the basis of the Federal Planning Bureau's forecast of macroeconomic variables – use estimated

1 This concerns around 85 % of the tax revenues collected by the federal government.

Chart 4

Estimates versus actual tax revenues [1]

(in € billion)



Source: Federal government budget documents.

1 This concerns the tax revenues collected by the federal government on a cash basis. If there is a change in timing of collection between the initial budget and the actual figures, an adjustment is made in order to obtain comparable figures.

income elasticities to arrive at the estimate of the tax categories concerned, assuming no change in policy. The impact of policy measures and any technical adjustments is then added to obtain the final estimate of the income categories concerned. Other tax revenues are estimated by the federal administrations concerned, using ad hoc methods.

Each February, the tax revenues for the current fiscal year are estimated as part of the March budget review. In the autumn, the tax revenues for the next fiscal year are assessed and that estimate forms the basis of the draft budget. In recent years, estimated revenues have sometimes deviated substantially from the actual figures. Deviations between estimates and actual figures are inherent in any estimation method and tell us nothing about the quality of the method used. However, if the actual revenues are systematically overestimated (or underestimated), there is an optimism (or pessimism) bias in the estimate and it is advisable to adjust the estimation methodology. Furthermore, excessive deviations may also indicate scope for improving the existing estimates. An evaluation of tax revenue estimates using the disaggregated method, by Decoster et al. (2017), shows that over the period 1990-2017 these tax revenues were systematically overestimated.

Deviations in estimates based on the disaggregated method may be due to four possible reasons: (i) a deviation in the starting point, i.e. the estimate of revenues for the previous projection year, (ii) a deviation in the estimate of the macroeconomic parameters, (iii) a deviation resulting from the specification of the methodology used [1], and (iv) a deviation in the estimate of the impact of policy measures. Decoster et al. (2017) clearly demonstrate that the observed deviation in the estimates is due – at least partly – to the deviation in the macroeconomic parameters used and in the assessment of policy measures.

1 This mainly concerns the estimated income elasticities and the choice of the macroeconomic variables used.

The quality of the estimates could therefore be improved by using a more appropriate assessment of the impact of policy measures, based as far as possible on theory, and communicated transparently. In that sense, it is also advisable to get an independent institution verify the quantification of the impact of these measures, as in the Netherlands, for example. Moreover, in the case of policy measures whose exact budgetary impact is difficult to assess – such as measures to combat tax evasion – the estimate should be conservative or only stated as a token entry (p.m.).

When focusing only on the impact of the methodology used – and making abstraction of other causes of error, it seems that the current specification of the disaggregated method generally performs well, and yields better predictions than specifications used previously.

Finally, Decoster *et al.* (2017), like the Court of Auditors (2017), point to the need for adequate documentation and support for the methodology for estimating revenue other than by the disaggregated method. For instance, in recent years the ad hoc projection of withholding tax revenues has been systematically overestimated to a substantial degree, and this factor has contributed significantly to the overestimate of tax revenues. Systematic assessment of these revenues is therefore also advisable.

2.2.2 Best practices

In most euro area countries, the tax revenues are estimated by the Ministry of Finance. Among the few exceptions are Germany and the Slovak Republic[1]. Outside the EU, the UK can be seen as applying best practice. Since 2010, the Office for Budget Responsibility is charged with both macroeconomic and revenue projections. These projections include the impact of all budgetary and fiscal measures adopted by the government. The latter is forced by law to use these projections when preparing its budget.

In Germany the estimate of tax revenues is prepared by a dedicated advisory council, the Working Party on Tax Revenue Estimates. In addition to representatives of the Federal Ministry of Finance, members include the Federal Ministry of Economics and Technology, five economic research institutes, the Federal Statistical Office, the Bundesbank, the German Council of Economic Experts (GCEE), the finance ministries of the Länder and the Federation of German Local Authority Associations.

In practice, eight of its members, namely the economic research institutes, the Bundesbank, the GCEE and the Federal Ministry of Finance produce, independently of each other, their own proposed estimates for each individual tax. These proposed estimates are the subject of discussion in the working party. The working party discusses each tax until a consensus has been found. The revenue expected to accrue to the German federal government, the Länder, the local authorities and the EU is extrapolated based on the estimates for the individual taxes. Directly after the meeting, the results are put online. Ever since the Working Party was established, the federal government has adopted the results for the federation's tax revenue in the budget.

As a rule, the working party estimates tax revenue on the basis of current tax law and government macroeconomic forecasts. Changes in the law are considered only if they have already passed the legislative process. Generally, the government adds the impact of legislative changes that are planned but haven't yet passed the legislative process. The extra revenue or shortfalls projected in the tax law amendments or the drafts thereof always relate to the primary fiscal effects, i.e. the effects on the types of tax directly affected by the respective measure. Second-round effects are taken into account at an aggregate level by means of a macroeconomic projection drawn up to reflect the changes in tax law. In recent years, positive surprises have dominated especially for profit-related taxes.

In the Slovak Republic, the tax projection is prepared by the Ministry of Finance but is subject to an assessment by an independent committee, the tax revenue forecast committee, comprising representatives of the central

1 Another good practice is that of assessing ex post whether there are systematic biases in the Ministry of Finance's projections. An example of this is a 2018 report of the Audit Committee of the Finnish Parliament.

bank, commercial banks, the Institute of Informatics and Statistics and the Council for Budget Responsibility (fiscal council), plus observers. In recent years, tax forecasts by all forecasting institutions (Ministry of Finance, central bank and fiscal council) proved to be mostly underestimated.

2.3 Budget monitoring and control

The purpose of budget monitoring is to detect any derailments as quickly as possible. In Belgium, there is a legal obligation to review the implementation of the federal budget during the year (in the spring), and, if necessary, to make adjustments. Similar budget control procedures are foreseen for the Regions and Communities. In most other EU countries, a budget review also takes place during the year but in very variable forms.

In Belgium, there is sometimes also "monitoring" of the implementation of the budget at the federal government level. However, that takes place on a rather irregular basis and with no clearly specified obligations. In contrast to the initial budget and the budget review, the results of such regular monitoring of the implementation of the budget do not have to be presented as such to parliament. There are no automatic correction mechanisms if it is found that the budget outcomes deviate from the initial estimates.

The federal Monitoring Committee plays a key role in budget monitoring and reviews. It was established by the caretaker government in May 2010. It comprises the chairmen of FPS Policy and Support (Budget), FPS Finance and FPS Social Security, the chief executives of the RSZ-NSSO, the RSVZ-INASTI and the RIZIV-INAMI, and the head of the Finance Inspectorate. This committee has the task of monitoring developments regarding State revenue and expenditure, producing forecasts and issuing regular, accurate reports on the current and future budget position. The reports produced periodically by the macro-budgetary service of FPS Policy and Support (Budget) are used, among other things, as the basis for the budget discussions with a view to drawing up the federal government's budgets. Since these reports are produced by the authorities on the basis of their figures, they provide a clear and accurate picture of the budget position and the efforts needed to achieve the targets. The creation of this committee has clearly strengthened the Belgian fiscal framework.

2.4 Multiannual budgetary planning

Multiannual budgetary planning is an instrument that enables the government to extend the budget policy horizon beyond the traditional annual calendar. The introduction of such a framework is advisable since most budget measures have an impact that goes beyond the fiscal year. The main advantages of introducing multiannual planning therefore concern the greater transparency of the medium-term objectives of fiscal policy, greater fiscal policy time consistency, and the visibility of trends in public finances.

There is a consensus that multiannual planning is crucial to an effective fiscal policy. The European Directive on national budgetary frameworks encourages multiannual planning. This has led to considerable reinforcement and expansion of the medium-term frameworks in most EU countries, as is clear from the movement in the index produced by the EC on the presence and quality of these frameworks[1]. Since 2006, the index has risen significantly for the euro area, especially during the period 2010-2015. However, it is still well below the maximum value of 1, which indicates that there is scope for further improvements.

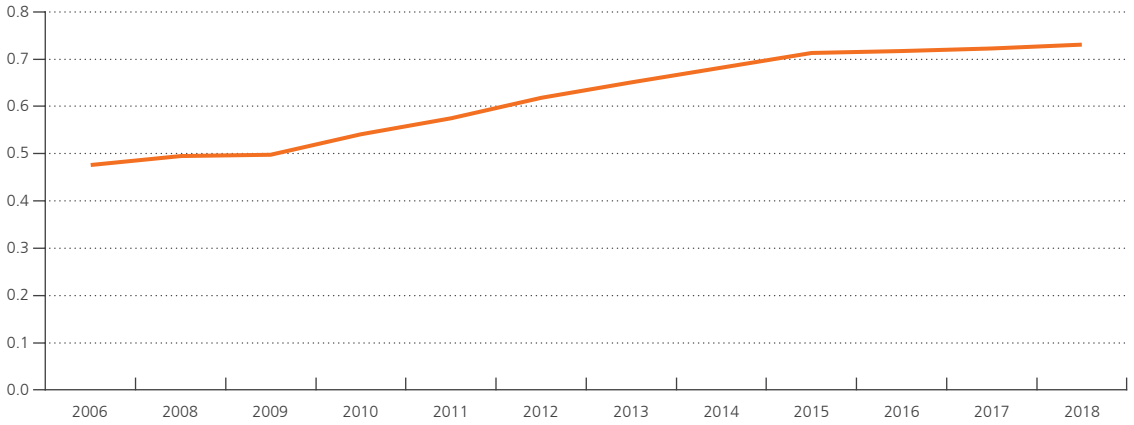
According to research by the EC, the success of multiannual fiscal planning depends on various factors in which the degree to which the targets are binding is crucially important. The degree and frequency of adjustments

1 In its fiscal governance database, the EC has developed several indicators which measure the strength and quality of the national budgetary frameworks of the EU Member States. These indicators measure the quality of the fiscal rules, the independent fiscal institutions and the medium-term framework. They are based on responses by the administrative authorities responsible for fiscal policy in the countries concerned. The results should therefore be interpreted with due caution. The information on these indicators is available in a database with 2018 as the most recent observation year.

Chart 5

Index of the quality of medium-term budgetary frameworks [1]

(unweighted euro average, between 0 and 1, a higher value indicating a better quality medium-term framework)



Source: EC.

1 This index measures five dimensions of medium-term budgetary frameworks: coverage of the targets/ceilings included in the medium-term fiscal plans, connectedness between the targets/ceilings included in the medium-term fiscal plans and the annual budgets, involvement of national parliament or use of a coalition agreement in the preparation of the national medium-term fiscal plans, involvement of independent fiscal institutions in the preparation of national medium-term fiscal plans, level of detail included in the medium-term fiscal plans.

to the forecasts also play a major role. A third factor that helps to determine the success of such a framework is whether the differences between outcomes and targets are explained. Finally, it is also important for such a framework to involve all echelons of government, with clear agreements between them on the definition and attainment of the budget targets. The success of such programmes therefore depends not only on their composition but equally on monitoring and compliance. Recent research by the EC has already shown that well-designed multiannual fiscal planning has a very strong beneficial impact on the budget outcomes and thus strengthens fiscal discipline.

Just as in other EU countries, Belgium's stability programme contains budget targets that extend beyond the traditional one-year horizon. However, the level of detail is limited, and the targets are not so stable and reliable as time goes by, since they may be revised. Furthermore, experience has shown that the targets stated in these stability programmes are often not met. They therefore cannot be regarded as fully developed multiannual planning for the budget.

According to the results of the WGPF survey, Belgium is the only euro area country without any full developed multiannual fiscal planning at national level apart from the stability programme. It therefore seems right to introduce such multiannual planning, in particular at the level of the federal government. In some other parts of the Belgian government, there is already a multi-annual budget framework, for instance for local authorities as well as to a certain extent for some Regions and Communities. For inspiration, we can look to the Netherlands which has such a framework already for a long time, and which is generally regarded as representing best practice. This is discussed in more detail in the section on fiscal rules (box 1). The Flemish multiannual budget framework is another example which could provide inspiration. Every year the Flemishgovernment produces a multiannual

estimate which covers a period of six years, including the current year. The multiannual estimate translates unchanged policy and the policy options chosen when drawing up the budget into an indicative multiannual fiscal forecast and predicts how the Flemish regional government's budget will turn out. The multiannual estimate is assessed each year during the draft budget process and adjusted to changing circumstances.

2.5 New developments

2.5.1 Costing of electoral programmes

The Law of 22 May 2014 gave the Federal Planning Bureau responsibility for costing the electoral programmes of the political parties represented in the House of Representatives.

This costing took place for the first time in the context of the federal elections held on 26 May 2019. The political parties had until the end of January 2019 to submit the measures necessary to achieve their electoral programme priorities. The FPB then produced a draft costing, focusing on the impact of the measures on public finances, employment, the purchasing power of population groups, social protection, mobility and energy. In the ensuing consultation, the parties had the opportunity to adjust certain measures. Throughout the procedure, the exchange of data remained confidential. The FPB published the results of the costing on 26 April 2019. This exercise also follows on from the "Rekening 14" campaign by the newspapers, De Tijd and De Standaard, and the VRT (the Flemish public broadcaster), at the time of the May 2014 elections, calling for the programmes of the parties represented in the Flemish Parliament to be costed by a team coordinated by Professor André Decoster of KU Leuven.

This costing of electoral programmes forms an extension of the Belgian fiscal framework. In this respect, the Belgian federal government is following the example of some other countries which have a tradition of instructing independent institutions to cost the impact of electoral programmes. The costing conducted by the Central Planning Bureau in the Netherlands since 1986 is often taken as the benchmark here, both because of the costing procedure followed and because of the importance attached to it in the electoral debate[1].

The primary aim of costing electoral programmes is to enhance transparency. Objective assessment of the impact of the proposals by an independent, harmonised analysis will give voters the information that will ultimately enable them to cast their vote with a greater awareness of the issues. Costing can also be expected to result in the disciplining of political parties, restraining them from putting forward proposals which are barely affordable or beyond the means of public finances. Costing could thus make a significant contribution towards the sustainability of public finances.

The Federal Planning Bureau made an impressive job of the costing, especially as this was a new task and imposed considerable additional pressure of work on the institution in that period. It is also good that the FPB used the associated preparations to develop new analysis instruments, particularly micro simulation models which, among other things, can identify distributional issues. Conversely, there are also some points on which the costing did not entirely come up to expectations. For instance, the political parties paid little attention to the necessary fiscal consolidation by means of proposals for bringing down the budget deficit: the costing results showed virtually constant or rising deficits for all parties, though it would have been desirable to reduce the deficit after the elections. The impression is therefore that the political parties were reluctant to formulate proposals which would cut the deficit via increased government revenues or lower expenditure, but which would also have a negative influence on household disposable incomes. The parties themselves largely took charge of communication concerning the costing, and made little mention of the budget challenge aspect, especially as the press paid little attention to that before the elections.

1 The costing of electoral programmes in the Netherlands is not based on any law but is the result of a tradition which has developed since the 1986 elections.

Nevertheless, the costing of electoral programmes is a sensible extension of the Belgian budgetary framework. However, if this instrument is to work properly, the role of the Federal Planning Bureau needs to be supplemented by the willingness of the parties to be as honest as possible about their plans and the associated measures, and the press needs to take a critical view.

2.5.2 Spending Reviews

An instrument for improving the quality of public finances

A spending review is a coordinated, in-depth analysis of public spending, aimed at detecting potential efficiency gains or reducing non-priority expenditure. These assessments are becoming increasingly widespread and recognised as a tool for improving the quality of public finances and boosting their ability to support the economy's competitiveness and growth.

Analyses of this type rely on the assumption that some aspects of public spending could be more effective. This means either that the same service could be provided at lower cost, or that a better service could be achieved without any increase in cost, thanks to a better allocation of resources. A high level of funding does not always guarantee that public authorities will perform well. Sometimes there are counter-productive factors at play, such as complex procedures or substantial partitioning of public services.

Conceptually, there are two different approaches to spending reviews (Vandierendonck, 2014). First, a strategic approach which questions the actual use of public funds to finance a policy or an entity. After the strategic approach comes the tactical approach, which entails ensuring that the level of public funding is more in line with the results achieved.

Spending reviews are complex processes requiring many types of expertise: knowledge of administrative processes, data analysis, estimates of costs and savings, transformation of organisations, etc. They can help to achieve fiscal consolidation targets, but also create scope for new policies, such as new investments and expenditure to stimulate growth. In view of the difficult fiscal context, this tool could prove extremely useful, especially if it becomes a permanent part of the budgetary process.

Increasingly being introduced by European Union Member States

In 2016, the Eurogroup called on euro area Member States to conduct spending reviews. A survey conducted by the EC in 2019 found that 43 spending reviews were carried out in the euro area, or 13 more than in 2017. The relevant practices are not the same everywhere. Spending reviews fall into three categories:

- full reviews covering a large part of the expenditure or the public authorities (Finland, France, Ireland, Italy, Luxembourg);
- thematic reviews covering only certain types of expenditure but representing a substantial proportion of public spending, such as health care, education or social benefits (Slovakia, Slovenia);
- targeted reviews covering specific branches but representing a small proportion of expenditure. This applies to the majority of spending reviews. Examples include the assessment of public contracts and the allocation of powers between entities (Germany), or the judiciary (Austria).

Regarding spending review frequency, some countries such as the Netherlands and Germany conduct targeted reviews every year. Conversely, Ireland for example conducted a full review every two to three years between 2009 and 2014, contributing to its fiscal consolidation. In the following years, Ireland has carried out a series of more targeted reviews providing input for the budgetary process each year.

The lack of data and staff resources are two recurring problems mentioned in connection with spending reviews. Only 16 of the 43 spending reviews covered in the EC survey were completed in 2019; it is still too soon to assess the results, and especially to determine whether they meet the set objectives and targets.

A tool still underdeveloped in Belgium

In its latest Country Report on Belgium, the EC stresses that spending reviews can help to improve the composition and effectiveness of public spending in order to respond better to the economic and societal objectives (EC, 2020e). Earlier studies have in fact pointed out that there is room for improvement in public sector efficiency (Cornille et al., 2017).

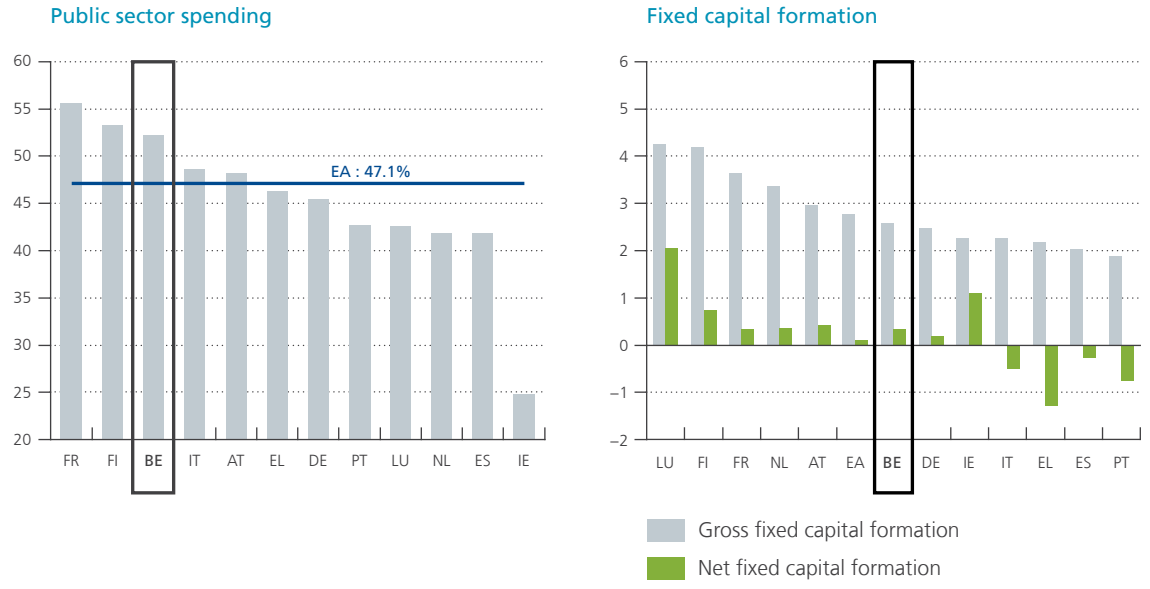
In Belgium, spending reviews take place in the context of high public expenditure which, in 2019, amounted to 52.2 % of GDP, compared to an average of 47.1 % of GDP in the euro area, representing the third highest ratio in the euro area after France and Finland. In the past two decades, the rise in public expenditure has, on average, outpaced nominal GDP growth. Conversely, new public investment remains low, barely covering the amortisation of earlier investments. For many years now, the stock of fixed capital has recorded only very modest growth.

Against that backdrop, in 2015 the council of ministers approved, at federal level, an initial project for optimising public sector spending and improving the efficiency of public services. That plan comprised various dimensions: standardisation of procurement policy, improvements in revenue collection and the management of property assets, and excellence initiatives concerning security and health care. One aspect also focused on the merger of certain horizontal federal public services. Two dimensions were added subsequently: operational excellence initiatives for the federal government's research departments, and the digital transformation of government. Following this exercise, some federal public services were merged in 2017 (creation of FPS BOSA), a central

Chart 6

Public spending and investment

(2019, % of GDP)



Source: EC.

procurement office was set up, and a plan was launched for the management of the federal government's property assets.

Following this initial experience of a targeted spending review, the federal government should soon be launching a broader spending review, working jointly with the OECD and the European Commission. At present, this exercise is still in a preliminary phase but is likely to progress to a more active phase in the near future, since the recent federal government agreement mentions the use of spending reviews as a tool for improving the quality of public services and the functioning of the State.

Successive State reforms have transferred certain powers and resources to the regional authorities. Although the federated entities are now responsible for an increasing share of the expenditure, the situation in terms of spending reviews is variable.

In the Flemish Community, the Ministry of Finance and the Budget, supported by the European Commission's Structural Reform Support Service, conducted an initial pilot project in 2019 involving a targeted spending review in the service voucher sector. The results of that project will be used to develop spending reviews further in the Flemish Community and incorporate them as a structural feature of the annual and multiannual budget process. During 2021, reviews of major expenditure items are to be conducted in order to identify any savings and consider reforms. The results are expected next June.

In the Walloon Region, the zero-based budget principle will soon be extended to all the Region's competences. Although this is not a spending review, the aim is likewise to improve the management of public expenditure by systematically justifying spending on the basis of its usefulness and relevance when drawing up the budget, rather than preparing each budget on the basis of the one for the previous year. Similarly, the government of the Wallonia-Brussels Federation conducted the zero-based budget exercise as part of its October 2020 budget adjustment, and likewise selected a number of expenditure items that could be made more efficient. Specific analyses will be conducted shortly.

Regular spending reviews can undoubtedly help to improve the quality of public finances, particularly if the objectives are well defined and the spending review is anchored in the budget planning. That is not yet the case in Belgium. This is a tool which is set to become very important in the years ahead for the consolidation of public finances.

3. Fiscal rules

3.1 A changing situation

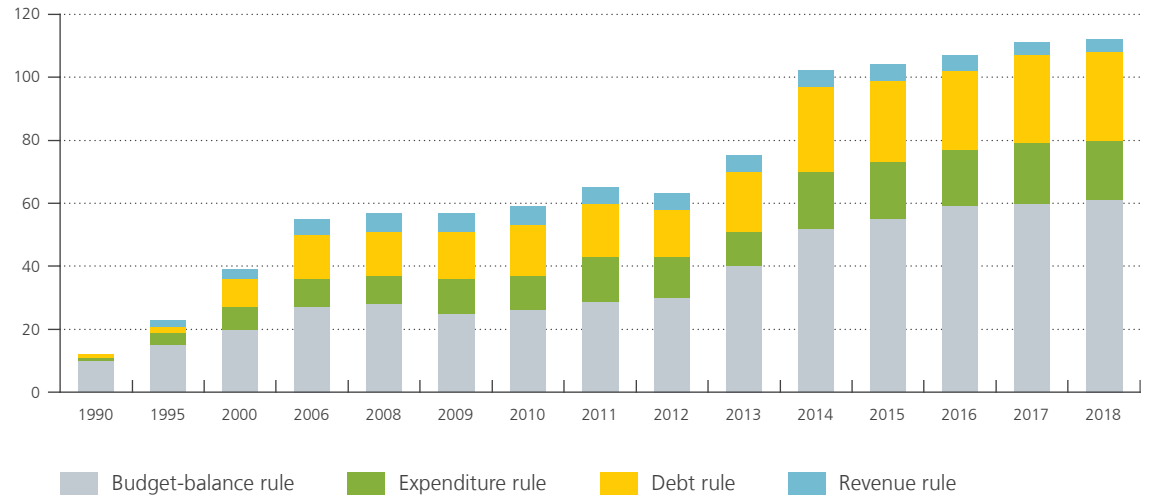
A fiscal rule can be defined as a permanent restriction on fiscal policy in the form of a synthetic indicator of budget performance. Fiscal rules specify numerical targets or limits for key aggregates of public finances, such as the budget balance, public revenue and expenditure, and the debt level. The determination of explicit numerical limits is based on the assumption that fiscal rules make deviations from those limits sufficiently costly for politicians, thus preventing systematic deviations and fostering greater fiscal discipline (Beetsma and Debrun, 2018).

Interest in a rules-based fiscal policy increased during the 1970s and 1980s when most countries experienced a serious deterioration in their public finances. From the early 1990s, more fiscal rules were gradually introduced. At first they were simple, with less emphasis on their enforceability. The financial and economic crisis was a catalyst for further development in this respect, leading to a second generation of fiscal rules. Typically, these rules are more flexible, specifying escape clauses for exceptional events and making provision for structural reforms to improve sustainability, and they are more practical to implement. However, the result has been to make the fiscal rules more complicated.

Chart 7

National numerical fiscal rules in the EU (1990-2018)

(number of rules)



Source: EC.

The EC's fiscal governance database contains two fiscal rule indicators. First, a Fiscal Rule Strength Index (FRSI) is calculated for each country for each fiscal rule and for each policy level on the basis of five criteria: the statutory/legal basis, the room for setting or revising objectives, the nature of the entity responsible for monitoring the implementation of the rule and the correction mechanism, the correction mechanism associated with the rule, and the resilience to shocks or events outside the control of the government. Each of these criteria is given a specific score: the higher the score, the stronger the rule. Next, the EC calculates a composite Fiscal Rule Index (FRI) for each country on the basis of the various FRSIs, taking account of the coverage of the index and the presence of different fiscal rules in certain countries.

According to the results for 2018, on the basis of the FRIs the countries with the most efficient fiscal rules were the Netherlands, Lithuania and Italy. The Dutch case is discussed in Box 1. On this subject, Belgium ranked just below the euro area average. In recent decades, this index has risen considerably for most countries, pointing to an improvement in the quantity and quality of the fiscal rules.

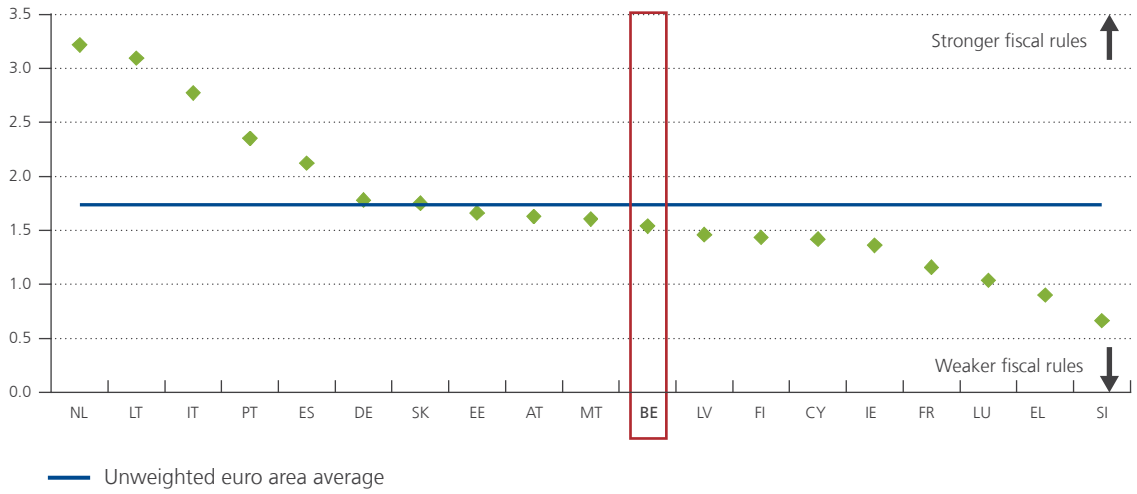
It is important to specify well-designed rules, since poorly designed rules do not produce the optimum results and could even entail a cost, e.g. because they encourage a procyclical policy or could lead to creative accounting. In the literature there is a broad consensus on several requirements that fiscal rules must meet in order to be successful. There are frequent references in this respect to the criteria put forward by Kopits and Symansky (1998).

First, a fiscal rule must be clearly defined and transparent. It must also be appropriate to the targets in view. A good fiscal rule must also be consistent, both in relation to other fiscal rules and as regards other policy goals. In addition, it needs to be enforceable and flexible. A fiscal rule should also preferably be simple. Finally, it must be effective in the sense that it ensures that the desired fiscal policy is pursued and that any necessary structural measures are taken.

Chart 8

Fiscal Rule Index

(2018 survey, index value)



Source: EC.

However, it should be noted that it is not possible to simply combine all these characteristics in a single rule. As more flexibility is built in, a rule becomes less simple. Also, a simple rule which makes no distinction between the policy and the fiscal implications of phenomena over which the government has no direct influence might be difficult to enforce. Fiscal rules will therefore inevitably be an imperfect compromise between all the requirements stated above.

BOX 1

The Netherlands as an example of best practice for fiscal rules and medium-term budgetary planning

The Netherlands can be considered as a best practice both in terms of medium-term budgetary planning and fiscal rules (Bos, 2008; EC, 2010; Vierke and Masselink, 2017; OECD, 2019a). The Dutch fiscal framework is all the more interesting in that it predates the requirements set at the European level. Some of its components have actually been in place since as long ago as 1971.

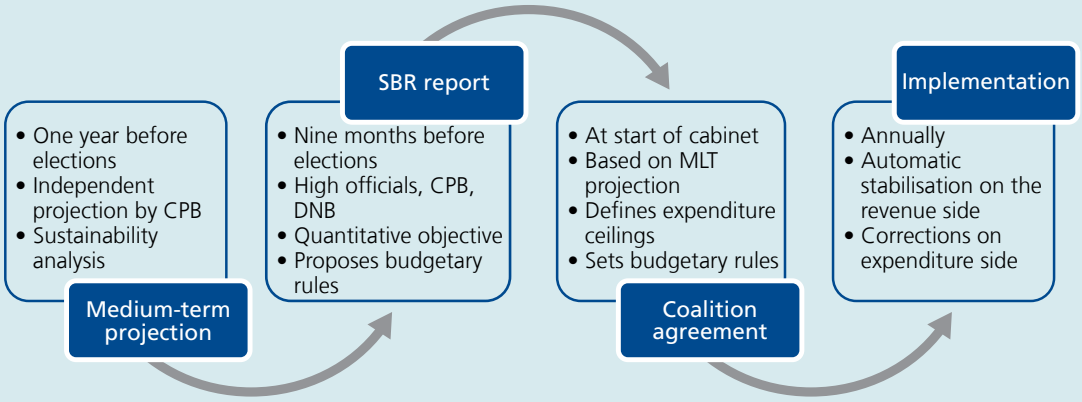
In practice, the Dutch budgetary framework works as outlined by Vierke and Masselink (2017). One year before scheduled general elections, the Centraal Planbureau (CPB) publishes a medium-term macroeconomic projection covering the next 4 to 5 years, corresponding to the next coalition period. It is based on an unchanged policy assumption and it includes an assessment of the long-term sustainability of public finances. This projection serves as input for a report published around nine months before the

general elections by the Studiegroep Begrotingsruimte (SBR). The SBR is a non-partisan advisory group on budgetary principles comprising high-level officials from various ministries, the director of the CPB and the President of De Nederlandsche Bank (DNB), the Dutch central bank. The incumbent Minister of Finance formally requests its advice, and this was last done on 10 July 2020. On the basis of the CPB medium-term projection, the SBR assesses the room for fiscal manoeuvre and defines quantitative budgetary objectives. Although not binding, its recommendations usually have an influence on the political parties' programmes. The SBR can also assess the effectiveness of the budgetary framework and propose changes to the fiscal rules. In this regard, an often-mentioned example of the SBR's influence is the 1993 report which proposed switching from deficit-focused policy to trend-based budgetary planning with multiannual fixed real expenditure ceilings, which are still a key feature of the Dutch budgetary framework.

After the election, the coalition parties set the rules for the next four annual budgets. The coalition agreement is therefore the most important moment for deciding on budgetary policy every four years. This explains why the negotiations tend to be lengthy and why the agreements are very detailed. Indeed, if a government or a coalition party wants a change in the agreement, it needs to provide an alternative with the same budgetary impact (van Veldhuizen, 2018). The coalition agreement defines multiannual real expenditure ceilings (in levels) for three main budgetary areas (central government, social security and health care) and sets benchmarks for the revenue side. In particular, the coalition agrees on discretionary tax measures and on the desired development of the tax base. Since 2017, the expenditure rules include interest charges but not the cyclical part of unemployment and welfare spending.

During the negotiations to form a government, the CPB will analyse the coalition agreement once the final decision by the political parties is imminent, providing information on the impact on key variables

The setting of fiscal rules in the Netherlands during the electoral cycle



CPB = Centraal Planbureau (Bureau for Economic Policy Analysis)
MLT = Middellangetermijnverkenning (Medium-term projection)
SBR = Studiegroep Begrotingsruimte
DNB = de Nederlandsche Bank

Source: Vierke and Masselink (2017).

(economic growth, unemployment, government deficit and sustainability). When the decisions are taken, it adjusts its medium-term baseline on the basis of the coalition agreement. This is then integrated in a new multiannual budget by the Ministry of Finance and results in the Startnota (initial budget memorandum) that includes the expenditure ceilings.

The trend-based principle implies that while revenues are allowed to fluctuate over the cycle, the expenditure ceilings have to be respected. During the term of the parliament, any breaches of the expenditure ceilings must, in principle, be offset within the sector; windfalls must first be used to compensate for setbacks within that sector. Apart from this, there is no automatic correction mechanism. Windfalls cannot be used for new expenditure. In practice, in recent years, shortfalls in the planned spending on some specific categories such as infrastructure were rolled over to subsequent years. Also, breaches of expenditure ceilings for certain subsections of government – notably healthcare – are often offset by expenditure cuts in other sections, even though this is formally only allowed in exceptional cases. On aggregate, however, the framework functions well according to stakeholders.

On the revenue side, additional tax increases are offset via tax relief and vice versa. Only changes in statutory tariffs are taken into account. Increases in tax revenue due to economic developments are disregarded. A common practice has also involved revenue rules. One rule obliges the government to pre-allocate higher than expected revenues (windfalls) to lower debt. Another rule defines tax burdens as a percentage of GDP. In recent years, given the budget surplus, the government has decided to circumvent the rule and provide tax relief in addition to plans decided on at the start of the coalition.

3.2 Current fiscal rules in Belgium

At present, a number of fiscal rules apply in Belgium and they will be described below.

Targets for the general government nominal and structural budget balance

Under the Stability and Growth Pact, Belgium has to draw up a stability programme each year, setting out budget targets for the medium term. Those targets are not strictly binding, and in past years the objective of achieving a structurally balanced budget has been regularly postponed to the future.

Health care expenditure targets

In 1994 the federal government introduced expenditure targets for health care. The real growth of that expenditure was to be limited to 1.5 % per annum. After a number of upward and downward adjustments, the federal government has restored the target of 1.5 % per annum since 2015. Up to 2018, decisive measures ensured that the rise in health care expenditure remained below that target. The federal coalition agreement of 2020 set that growth target at 2.5 % per annum from 2022.

Targets for Communities and Regions

In a federal State, it is logical for each entity to contribute towards the attainment of the budget targets applicable to general government. Following the sixth State reform, the generally accepted approach was that each entity

would move towards balance in the medium term. The cooperation agreement of 13 December 2013 provides a formal framework for budgetary coordination in Belgium. We shall return to this in section 5.

Legal restrictions on local authority balances

In 1982, a strict budgetary framework was imposed on local authorities to put an end to the large deficits of those days. The equilibrium principle for the municipalities was introduced via a special decree which was later incorporated in the Municipal Law. This rule, which was mandatory from 1988 onwards, de facto obliges the municipalities to produce a broadly balanced budget.

By law, the finances of other local authorities, such as police districts, emergency rescue districts and public social welfare centres must also balance at all times. If their budget is found to be in deficit, then the municipality concerned has to correct that deficit by means of grants so that the equilibrium principle is always respected.

However, it should be noted that since the regionalisation of the Municipalities and Provinces Law in 2002, the Regions have power to exercise supervision over local government finances. As a result of that regionalisation, municipal accounting in the three Regions is now subject to different rules and targets, and different criteria apply to the equilibrium principle. This rule has worked well in that local authority accounts in Belgium are sound from a macroeconomic point of view.

3.3 Adjustment proposals

There is a growing consensus that expenditure rules can be an effective way of fostering fiscal discipline. At present, 12 of the 19 euro area countries use an expenditure rule for general government. The attraction of such rules increased after the financial and economic crisis, the main reasons being that they concern an indicator over which the government has direct control, and they are simpler and more transparent than rules applicable to other indicators such as the structural balance. For Belgium, an expenditure rule is even more appropriate since public sector expenditure is very high and there is hardly any leeway on the revenue side. Good expenditure targets could be a powerful supplement to the budget balance targets set for general government and its subsectors.

However, as already stated, there is currently no focus on expenditure rules in the Belgian budgetary framework, except for health care spending. This is in contrast to the situation in the 1990s and the early 2000s, when various restrictions applied. For example, as part of the measures to bring down the budget deficit in order to comply with the Maastricht criteria, the 1992 federal coalition agreement set the target for the real growth of federal government expenditure excluding interest charges to be limited to 0 % or less. The 1995 coalition agreement confirmed this zero real growth target. In 1998, the year after testing against the Maastricht criteria for monetary union, the target was dropped.

Although the application of these budget targets was sometimes circumvented by debudgetisation techniques and alternative forms of funding, so that the expenditure growth recorded for the federal government in the government sector accounts often exceeded the target, there are strong indications that setting expenditure targets in this way did lead to restrictive measures. In that period, federal expenditure expressed as a percentage of GDP therefore declined.

At regional level, the Flemish Community will introduce an expenditure target. It was one of the proposals in the final report of the economic advisory committee established by the Flemish government in the Spring of 2020 with the task of devising measures for a strong and rapid recovery and for safeguarding welfare and prosperity. The Flemish government welcomed the proposal and in its September 2020 statement it announced that an expenditure target would be adopted with effect from the 2022 budget.

4. Independent fiscal institutions

4.1 Role

Independent fiscal institutions play a key role in the conduct of fiscal policy. These are public, politically independent entities responsible for watching over the sustainability of public finances. To that end, fiscal institutions may have positive or normative powers. In the former case, they typically provide macroeconomic forecasts. In the latter case, they set targets in terms of fiscal discipline and assess the policies pursued in the light of those targets. These fiscal councils may also provide input for discussions on public finances by making other recommendations.

Independent fiscal institutions gained fresh momentum with the rising deficits and public debts caused by the 2008-2009 economic and financial crisis. Since a close watch was maintained on commitments in favour of sustainable public finances, decision-makers looked for new ways of preserving fiscal discipline and restoring confidence in their ability to manage budgets prudently and transparently. As a result, the number of fiscal institutions in the OECD countries has more than tripled over the past decade and is still growing.

The relevance of Independent fiscal institutions depends on several factors. For instance, the institution must have a clear and unequivocal mandate. A second factor concerns the fiscal institution's independence, which must be guaranteed in both legal and financial terms. The influence of an independent fiscal institution also clearly depends on its credibility. In that regard, great transparency is crucial, and is guaranteed for example by publication of the models and data used. One last factor that determines its influence is the extent of its involvement in the budgetary process. That is greater if the institution is heard by parliament and consulted regularly by the government, and if it is asked to provide independent forecasts when the budget is being prepared or when the government needs to justify deviations from the estimates or the recommendations (Dury and Van Meensel, 2008).

4.2 Situation in Belgium

In Belgium, two entities perform the functions traditionally devolved to independent fiscal institutions: the Federal Planning Bureau (FPB) responsible for preparing the macroeconomic forecasts mentioned above, and the High Council of Finance, via its "Public Sector Borrowing Requirement" section[1], which is described in the following paragraphs.

Creation

The "Public Sector Borrowing Requirement" section was set up by the special law of 16 January 1989. Against the backdrop of Belgium's conversion to a federal State, the creation of an advisory body was intended to facilitate the coordination of fiscal policies between the country's various entities.

Composition

The "Public Sector Borrowing Requirement" section has twelve members, appointed for renewable five-year terms and chosen for their particular competence and experience in the financial, budgetary and economic spheres. Six of them are appointed on the proposal of the governments of the Communities and Regions. Since 2019, the section has been chaired by Pierre Wunsch, governor of the National Bank of Belgium. In the preparation of its work it is assisted by a secretariat, which is currently provided by FPS Finance officials.

1 In the rest of the article, we shall use the terms "HCF" and "section" indiscriminately to mean the HCF "Public Sector Borrowing Requirement" section.

Mission

The section conducts assessments and makes recommendations on the subject of fiscal policy. These primary tasks are specified in the Cooperation Agreement of 13 December 2013, which transposes the provisions of the Treaty on Stability, Coordination and Governance in the Economic and Monetary Union (fiscal compact) and which was approved by the parliaments of the federal government and of the Regions and Communities. In that regard, two reports are published each year:

- in March/April, in connection with the preparation of the stability programme, an opinion on the budget path which the government should follow over the next three years and the allocation of these budget targets among the various levels of power;
- in June/July, an opinion on the assessment of compliance with the commitments entered into by the various levels of power and execution of the previous year's stability programme.

If the section finds a major discrepancy between the actual budget outcomes and the budget target of the level(s) of power concerned, there is provision for automatic activation of a correction mechanism. The section then has to issue an opinion on the scale of the correction measures required, followed by another opinion verifying their implementation.

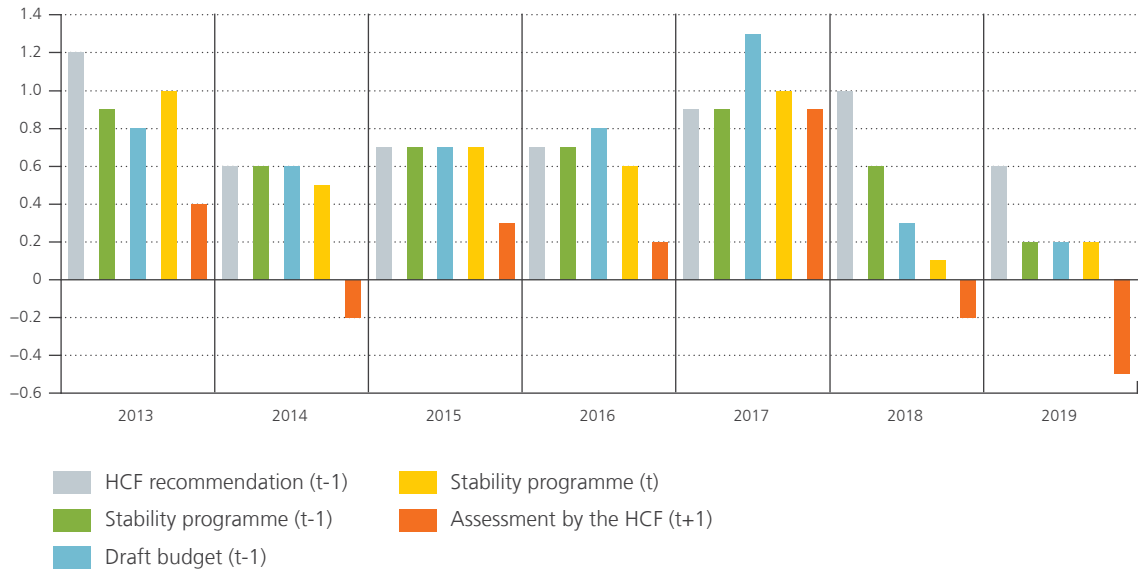
Assessment

The effectiveness of an independent fiscal institution has to be judged by the results achieved. In that regard, the HCF's "performance" has fluctuated over the past three decades.

Chart 9

Year-on-year change in the structural balance

(percentage points of GDP)



Sources: HCF, budget documents.

During the period preceding the adoption of the euro, the Maastricht convergence criteria and the objectives of the HCF and the political decision-makers were aligned, and the section's recommendations were largely followed. After the introduction of the euro, the section's recommendations had less influence on fiscal policy (Coene and Langenus, 2013).

Since 2013, the HCF has proposed a path for the structural budget balance. On this subject, the ex post observations have never exceeded either these recommendations or the fiscal intentions of the Belgian authorities. The evolution of the structural balance has always deviated substantially from that planned in the budget. On average, the gap amounted to 0.5 percentage point of GDP over the period 2013-2019 and is relatively stable over time. Conversely, there is better alignment of the paths recommended by the HCF, adopted in the stability programmes and incorporated in the budget plans. The challenge for Belgium therefore lies more in the execution than in the definition of the budgetary guidelines. Nevertheless, the evolution of the structural balance might have been less favourable if there were simply no recommendations.

Also another recurrent failing on the part of the Belgian authorities has a direct impact on the work of the HCF: in the absence of political agreement on the budget targets for the individual levels of power, the said correction mechanism cannot be applied. The next chapter will return to the shortcomings of interfederal budget coordination in Belgium.

In the recent past, the EC has addressed other remarks to Belgium, highlighting the need to ensure the independence of the national fiscal institution responsible for verifying compliance with the European fiscal rules. It made three requests: (i) explicitly ensure that the section's members and its functioning are independent of all external influence, particularly that of the fiscal authorities and political power, (ii) guarantee its total autonomy in the communication of its opinions, and (iii) provide sufficient resources, including a dedicated secretariat and a ringfenced budget allocation.

In response to these observations, the Royal Decree of 23 May 2018 on the HCF introduced changes in the functioning of its "Public Sector Borrowing Requirement" section. The members are still proposed by the various authorities, but are no longer deemed to represent them. The HCF may also engage in any type of public communication, totally independently and without any restrictions or censorship. That reform also introduced other new features which have not yet been implemented, such as an annual budgetary credit line, which increases its financial independence. In particular, the Royal Decree foresees the extension of the staff – actually 3 to 5 people – to a ten-person secretariat, of which five are proposed by the federal finance and budget services and five by the Regions and Communities' administration.

Although the remarks of the EC are correct from a formal perspective, the fact that the secretarial function was provided by the staff of the FPS Finance has never hindered the independence of the HCF's advices. Moreover, the section should be able to perform well its actual role as foreseen in the cooperation agreement of 13 December 2013 with a staff of 3 to 5 people. With the foreseen extension of the secretariat, to 10 people in total, the section should be able to perform new tasks. In any case, the section should have a managing director and develop back-up functions, especially for critical functions and sensitive applications.

The HCF's influence could also be strengthened by raising the political cost of discrepancies between the budget path and the recommendations, e.g. via the obligation of the government to justify such deviations publicly (before parliament) via a "comply or explain" mechanism. Its media presence could be facilitated by a genuine communication policy.

4.3 Foreign independent fiscal institutions and best practices

Created in 1989, the "Public Sector Borrowing Requirement" section of the High Council of Finance is one of the oldest independent fiscal institutions, even among those of the main euro area countries considered in the Annex 2.

As already mentioned, in the wake of the global financial crisis and the sovereign debt crisis, many euro area Member States fundamentally revised their existing fiscal framework in response to the strengthening of the EU governance. This included setting up independent fiscal councils in line with well-established OECD principles and with the guidance of the IMF in the context of the assistance programmes. At the beginning of 2020, all euro area countries had a fiscal council. The fiscal councils of Spain and the Slovak Republic created with the support of the IMF are often considered as examples of good practice: together with the central banks, they are also perceived by the stakeholders as the most independent and non-partisan bodies in their institutional landscape.

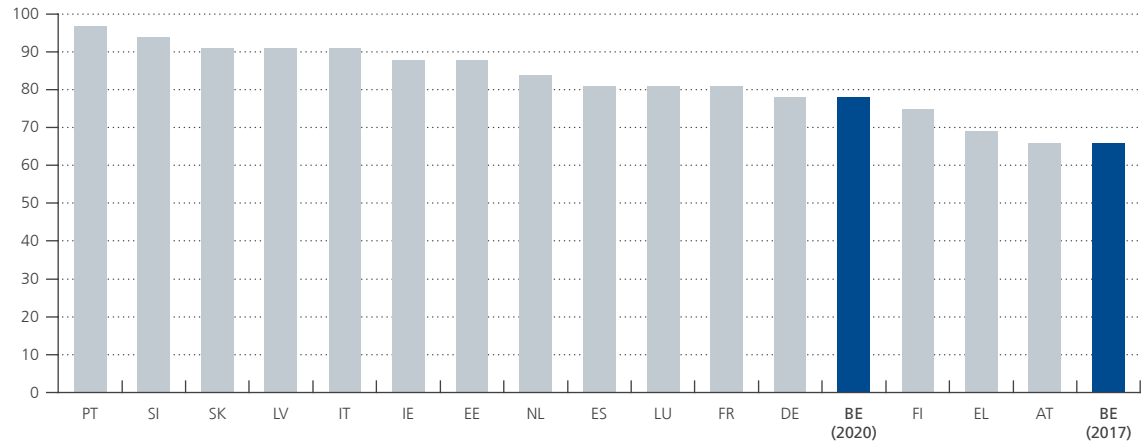
The Belgian fiscal council therefore now appears to rank below average. Until the 2018 revision of the Royal Decree, Belgium had the lowest score among the euro area countries in terms of independence, while countries which had received financial assistance, such as Portugal, Ireland and Spain, perform much better with respect to this criterion. According to a rough estimate, thanks to the 2018 reform, the Belgian position has improved somewhat but is still below average.

According to table 1 in Annex 2, a striking difference between the Belgian fiscal council and the new-generation fiscal councils relates to their organisation. In Belgium and in a few other countries, the key people in the council are the board members. These are more numerous than the staff and they have power to decide on policy guidelines and recommendations. In most of the recently established fiscal councils, the number of board members is very small and (far) below the head count. In Spain, for example, there are 35 full-time equivalents on the staff and there is no actual board: the full-time president assumes the role of a managing director, having

Chart 10

Independence of fiscal councils

(composite indicator[1], in %, 2017 unless otherwise stated)



Source: von Trapp and Nicol (2018).

1 The composite indicator includes the following components: leadership independence, operational independence, legal and financial independence, plus access to information and transparency. A higher value means a higher degree of independence.

full control over the hiring of the staff and also representing the institution. The staff's educational level is also outstanding. These new-generation councils have also developed a communication team, either in-house or via consultants, helping them to acquire high media visibility in a short period of time. It also helped that the first president (in Spain) or the first three members of the executive board (in the Slovak Republic) were outstanding experts in the field of public finance, recognised nationally or even internationally. In both countries, under their guidance and with the help of an external advisory panel, the staff have successfully developed models to perform their various tasks while they have also frequently testified in parliamentary hearings. Both countries have succeeded in ensuring the succession by nominating their second president/executive board.

The mandate of the fiscal councils differs widely across the euro area depending mostly on whether tasks had already been assigned to other actors (Annex 2 – Table 2).

All fiscal councils as defined by the EU budgetary framework monitor whether the fiscal position complies with the EU or national rules. In most cases, they can also trigger the corrective mechanism and consider escape clauses. In addition to these missions, some fiscal councils, especially those which are well-staffed, also have a mandate or a role which extends to assessing the long-term sustainability of public finances, providing policy costings, assessing the fiscal stance, contributing to the budget coordination among government levels and maintaining regular monitoring of the public finances at the various levels of government.

In fiscal councils which are well-staffed but nevertheless working under pressure, such extended mandates may lead to the regular publication of numerous reports. As an example, the Slovakian Council for Budget Responsibility (CBR) publishes regular budgetary "traffic light" reports that identify in-year risks of deviation from the initial budget balance targets. In Spain, the Independent Authority of Fiscal Responsibility (AIReF) also provides both ex ante recommendations and ex post assessment of the stability programmes and the draft budgetary plans.

The Spanish fiscal council is unique in the production of outputs concerning the subnational governments, in particular reports on the public finances of the various autonomous communities. "Stakeholders report that the AIReF's work has contributed to better fiscal management in Spain across the fiscal policy cycle. In particular, AIReF has helped generate improvements in economic forecast methods, the monitoring of budget implementation and early detection of non-compliance with fiscal rules. Subnational stakeholders view AIReF as an honest broker in national/subnational fiscal coordination. In relation to transparency, stakeholders across levels of government welcome the new economic and fiscal information provided by AIReF and note the contributions that AIReF has made more generally to promoting a new culture of transparency in Spain" (Von Trapp et al., 2017).

5. Budgetary coordination

5.1 Positioning

In many EU countries, fiscal policy is partly decentralised. The literature on fiscal federalism points out the advantages and disadvantages of such a policy. Decentralisation is generally based on political and economic motives: lower echelons of government are said to be better able to align the provision of public goods with local needs, thus enhancing government efficiency, while the national level benefits from economics of scale. However, the devolution of competences to lower echelons may also increase the vulnerability of public finances, as fiscal discipline is often harder to enforce at a lower level. In Belgium, there has been a marked tendency towards more regionalisation over the past 50 years.

This decentralisation also has implications for compliance with the requirements of the European budgetary framework, as its stipulations apply to the general government sector. This means that, in a federal state like

Belgium, where each entity contributes to the attainment of the overall budget targets, there is a need for effective, operational budget coordination.

5.2 The situation in Belgium

In Belgium's institutional structure, there is no hierarchy of legislation between the various levels of government. Consequently, all governments must concur before an agreement can be reached on the goals and the paths for achieving them.

In Belgium, since the mid-1990s budget coordination has taken the form of cooperation agreements on budget targets, concluded between the federal government and the governments of the Communities and Regions. The recommendations of the "Public Sector Borrowing Requirement" section of the High Council of Finance usually formed the basis for such cooperation agreements.

The cooperation agreement between the Federal Government, the Communities, the Regions and the Community Commissions of 13 December 2013, mentioned in section 4.2, stipulates that the annual budget targets relating to the stability programme are to be allocated in nominal and structural terms among the various policy levels on the basis of a recommendation by the "Public Sector Borrowing Requirement" section of the High Council of Finance. That allocation must be approved by a decision of the Consultative Committee, an entity comprising the prime minister and the minister presidents of the Communities and Regions. The "Public Sector Borrowing Requirement" section is also designated as the independent body whose responsibilities include maintaining supervision over compliance with those decisions, and more generally assessing respect for the commitments entered into by the governments.

Following evaluation of the targets, the section should also be able to indicate any party to the agreement deviating significantly from its target. If such a significant deviation is detected, an automatic correction mechanism is launched, whereby the entity concerned must justify its deviation and take the necessary corrective measures to put an end to the deviation within 18 months. On the basis of the section's recommendation, a longer period may be justified, depending on the institutional and economic reality, but it must not be contrary to any deadline that the European Union imposes on Belgium.

The section is also responsible for monitoring whether the correction measures are implemented, and issues an annual opinion in that respect.

Finally, the cooperation agreement states that any financial sanction imposed on Belgium by the Council of the European Union must be shared among the parties to the agreement in proportion to the failings identified by the Public Sector Borrowing Requirement section.

5.3 Evaluation

The lack of any hierarchy in the legislation means that Belgium has a unique institutional structure, and it is therefore impossible to adopt another country's best practice.

While the cooperation agreement of 13 December 2013 formalised the framework for budget cooperation between the federal government and the Regions and Communities' governments, it has never been implemented. The Consultative Committee has never yet managed to agree on the allocation of the budget targets included for general government in the stability programme. Moreover, the Consultative Committee has most of the time only taken note of the overall targets and thus has not formally approved them. Up to now, the budgetary coordination has therefore not been sufficiently effective.

The absence of effective budgetary coordination between the various governments has significant consequences. If there are no agreed targets for each level of government, the "Public Sector Borrowing Requirement" section of the High Council of Finance cannot determine whether there is any significant deviation, and the operation of the automatic correction mechanism therefore cannot be guaranteed. The section has therefore called on the governments to approve the overall and individual targets in the Consultative Committee. The EC and the Ecofin Council have also repeatedly expressed their concern over the lack of internal budgetary coordination and have rightly called on Belgium to pursue the full implementation of the 2013 Cooperation Agreement.

6. Conclusion

The national fiscal frameworks, comprising a set of procedures, rules and institutions forming the basis of the conduct of fiscal policy, have been modified and reinforced, primarily as a result of tightening of the EU directives on the subject following the financial and economic crisis. This article examined the main aspects of the Belgian fiscal framework and investigated which aspects work well and which could be improved.

The Belgian fiscal framework clearly has a number of strong points. For instance, if the economic growth forecasts underlying the stability programmes are compared with those produced by the EC, we find that, on average, Belgium's forecasts deviate little and demonstrate no optimism bias. Furthermore, they are very similar to the actual figures. Also, in recent years the Belgian fiscal framework has been strengthened in various respects. Examples include the creation of the federal Monitoring Committee, which performs a key role in budget monitoring and control. The reports that this committee produces usually provide a clear and accurate picture of the budget and of the efforts required to achieve the targets. The costing of the electoral programmes by the Federal Planning Bureau has also strengthened the fiscal framework since it has enhanced transparency.

Apart from these strengths, the analysis also clearly reveals a number of aspects of the Belgian fiscal framework which could be improved. First, there is the distortion in the estimation of tax revenues. The estimate's quality could be improved by better documenting and underpinning of the estimation methodology, greater transparency in the assessment of the policy measures, and a verification by an independent institution of the quantification of the impact of those measures.

A second aspect of the Belgian fiscal framework where improvements could be made concerns the introduction of multiannual fiscal planning, accompanied by an expenditure rule. The best practice applied by the Netherlands shows that a medium-term framework assigning a key role to the expenditure rule can make a significant contribution towards an effective fiscal policy. The introduction of such a framework will ensure an improvement in the transparency of the targets and the consistency of fiscal policy over time.

An adjustment which has already begun and which should continue is the further introduction of regular spending reviews. These ensure a critical appraisal of public expenditure and examine ways of improving efficiency. This is a useful exercise, certainly in the context of the high level of public spending in Belgium, and taking account of the necessary consolidation of public finances in the aftermath of the COVID-19 crisis.

Concerning the "Public Sector Borrowing Requirement" section of the High Council of Finance, it is necessary to choose between keeping the present number of staff and their set of duties, and completing the 2018 reform involving an increase in staff numbers. In the latter case, it should be able to perform new tasks.

One final possible improvement concerns budgetary coordination. Despite the existence of a detailed legal framework on the subject, this does not work properly in the absence of an agreement on the targets between the various governments. Following the Ecofin Council recommendations, attention must be drawn to the

importance of an annual agreement on the binding targets for the various governments. That creates clarity regarding each party's responsibility and facilitates independent monitoring by the High Council of Finance.

To sum up, the evaluation of the Belgian fiscal framework presents a mixed picture. Comparison with best practices in other euro area countries shows that the Belgian fiscal framework does well in a number of respects, but also that a number of aspects offer room for improvement. It is important to focus on this, since the suggested further adjustments could help to support the necessary consolidation which will come after the COVID-19 crisis, enhance government efficiency and thus guarantee the long-term sustainability of Belgian public finances.

Annex 1 – Main results of the WGPF survey on national fiscal frameworks

This annex summarises the answers to the most relevant questions for this article taken from the survey on national fiscal frameworks. This survey was conducted amongst the EU27 national central banks at the beginning of 2020 by the ECB Working Group on Public Finance (WGPF). The survey was previously organised in 2011, 2012, 2013, 2014 and 2015.

1. Budget process

1.1. The projections for the macroeconomic environment (GDP growth, unemployment, etc.) underlying the annual budget are prepared / assessed or endorsed (+/–) by an independent institution.

AT	BE	CY	DE	EE	EL	ES	FI	FR	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK
		+/–	+/–			+/–			+/–	+/–	+/–	+/–	+/–					+/–

1.2. The projections for the main government revenue items are prepared / assessed (+/–) by a separate independent institution.

AT	BE	CY	DE	EE	EL	ES	FI	FR	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK
			+/–												+/–			+/–

1.3. There is no upward bias in revenue projections (they tend to be more buoyant than EC or ESCB projections).

AT	BE	CY	DE	EE	EL	ES	FI	FR	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK

1.4. Is there a multi-annual budget/planning framework (other than the stability programmes)?

AT	BE	CY	DE	EE	EL	ES	FI	FR	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK
																+/–		

1.5. Is there an official budget review procedure during the year?

AT	BE	CY	DE	EE	EL	ES	FI	FR	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK
								+/–										

2. Fiscal rules

2.1. Do expenditure rules play an important role in guiding fiscal policy (other than the expenditure rule of the Stability and Growth Pact)?

AT	BE	CY	DE	EE	EL	ES	FI	FR	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK
						+/–			+/–									

3. Fiscal Councils

3.1. Is there a (functional and financially) independent fiscal council?

AT	BE	CY	DE	EE	EL	ES	FI	FR	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK
			+/–		+/–				+/–		+/–		+/–		+/–			

4. Fiscal federalism arrangements

4.1. Does there exist a kind of effective cooperation/commitments between the different government levels that goes beyond simple ad hoc negotiations? (or regular internal stability programmes or implicit budget coordination (+/–))

AT	BE	CY	DE	EE	EL	ES	FI	FR	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK
+/–	+/–		+/–		+/–			+/–		+/–		+/–	+/–		+/–	+/–	+/–	

Legend: green means yes.
red means no.
+/- means partly.

Table 1

Key organisational aspects

Country	Institution name	Creation year	Last change	Staff (full-time)	Council / Board	Nature of leadership: individual	Leadership has control over the hiring process for staff	Leadership commitment (full-time)	Leadership selection	External advisory panel
Austria	a) Fiscal Advisory Council (FISK)	1970	2013	6	15	○	◖	○	Various	○
	b) Parliamentary Budget Office (PBO)	2012	2012	8	0	●	◖	●	Open	○
Belgium	a) Federal Planning Bureau (FPB)	1959	2014	100	4	○	●	●	Government	●
	b) High Council of Finance – Section for Public Sector Borrowing Requirements[1]	1989	2013	3 to 5	12	○	○	○	Various	○
Finland	a) Monitoring and Evaluation of Fiscal Policy Function – National Audit Office	2013	2013	4	0	●	●	●	Various	●
	b) Finnish Economic Policy Council (EPC)	2014	2014	2	4	○	◖	○	Various	○
France	High Council of Public Finance (HCFP)	2013	2013	3	11	○	●	○	Various	○
Germany	Independent Advisory Board to the Stability Council	2013	2013	1	9	○	●	○	Various	○
Greece	a) Parliamentary Budget Office	2011	2016	11	5	○	◖	○	Parliament	○
	b) Hellenic Fiscal Council	2015	2017	15	5	○	●	○	Various	○
Ireland	a) Irish Fiscal Advisory Council (IFAC)	2011	2013	6	5	○	◖	○	Government	○
	b) Parliamentary Budget Office (PBO)	2017	2017	12	0	●	●	●	Open	●
Italy	Parliamentary Budget Office (PBO)	2014	2014	24	3	○	●	●	Parliament	●
Netherlands	a) Bureau for Economic Policy Analysis (CPB)	1945	2013	125	0	●	●	●	Government	●
	b) Advisory Division of the Council of State	2014	2014	3	3	○	○	○	Government	○
Portugal	Public Finance Council (CFP)	2012	2014	18	5	○	●	○	Various	○
Slovak Republic	Council for Budget Responsibility (CBR)	2012	2012	14	3	○	●	○	Various	●
Spain	Independent Authority of Fiscal Responsibility (AIReF)	2014	2014	35	0	●	●	●	Gov + Parl	●

Sources: ESCB WGPF questionnaires, OECD Fiscal Council database, Dutch Council of State, Federal Planning Bureau.
1 In Belgium, the Royal Decree was also modified in 2018 but all these changes have not yet been applied.

Table 2

Mandates and outreach

Country	Institution name	Analysis of long-term fiscal sustainability	Role in macroeconomic or fiscal forecasts	Role in monitoring compliance with fiscal rules	Correction mechanism / escape clause	Role in policy costing	Can the institution provide normative advice?	Leadership participates in parliamentary hearings	High media visibility
Austria	a) Fiscal Advisory Council (FISK)	●	●	●	●	○	●	●	●
	b) Parliamentary Budget Office (PBO)	●	○	○	○	●	◖	●	○
Belgium	a) Federal Planning Bureau (FPB)	●	●	○	○	●	○	○	●
	b) High Council of Finance – Section for Public Sector Borrowing Requirements	●	○	●	●	○	●	○	◖
Finland	a) Monitoring and Evaluation of Fiscal Policy Function – National Audit Office	●	●	●	◖	○	◖	●	●
	b) Finnish Economic Policy Council (EPC)	●	●	●	○	○	◖	●	○
France	High Council of Public Finance (HCFP)	○	●	●	●	○	○	●	○
Germany	Independent Advisory Board to the Stability Council	○	●	●	◖	○	◖	○	○
Greece	a) Parliamentary Budget Office (PBO)	○	●	●	○	○	●	●	○
	b) Hellenic Fiscal Council (HFC)	◖	●	●	●	◖	●	◖	○
Ireland	a) Irish Fiscal Advisory Council (IFAC)	○	●	●	○	◖	◖	●	●
	b) Parliamentary Budget Office (PBO)	○	○	○	●	●	○	◖	○
Italy	Parliamentary Budget Office (PBO)	●	●	●	●	●	○	●	◖
Netherlands	a) Netherlands Bureau for Economic Policy Analysis (CPB)	●	●	○	○	●	○	●	●
	b) Advisory Division of the Council of State	○	○	●	●	○	●	●	◖
Portugal	Public Finance Council (CFP)	●	●	●	○	○	○	●	●
Slovak Republic	Council for Budget Responsibility (CBR)	●	○	●	●	●	◖	●	●
Spain	Independent Authority of Fiscal Responsibility (AIReF)	●	●	●	●	○	◖	●	●

Sources: ESCB WGPF questionnaires, OECD Fiscal Council database, Dutch Council of State, Federal Planning Bureau.

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Fighting global warming with carbon pricing: how it works, field experiments and elements for the Belgian economy

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Introduction

The last few years have seen growing public concern about the environment in general, and global warming more particularly, which has led to massive demonstrations throughout the world. They have been temporarily stopped by the COVID-19 pandemic which has severely hit the global economy. Even though global warming is a long-run structural problem and the pandemic hopefully only a temporary one, several lessons can be drawn from the coronavirus crisis to better assess the climate issue, which is still a bit too abstract. First, the pandemic has illustrated the huge dependence of our economies on the use of carbon-intensive fossil fuels: when the global economy suddenly froze, carbon emissions dropped accordingly. Let us imagine for one minute that the causality had been reversed, that the fall in economic activity was forced by a need to reduce emissions. The dramatic COVID episode has the pedagogical virtue of highlighting the huge economic costs associated with a brutal reduction in carbon fuels combustion. The drop in carbon emissions in 2020 is forecast in the range of 4 to 7 %. It is revealing to compare this number with the 7.5 % yearly drop that is recurrently required to reach carbon neutrality by the 2050 horizon. Another comparison can be made regarding the time lapse during which the virus spreads through the population without perceivable consequences before provoking a sudden and exponential burst in hospitalisations and deaths. The same way, anthropogenic atmospheric carbon accumulated relatively unnoticed in the high atmosphere over the last two and a half centuries, but now comes the time where changes become more and more tangible. Even though lockdowns are extremely compelling and economically costly, they at least have the merit of being enforceable and stopping the virus from spreading while waiting for a vaccine. Once the costs of global warming explode, no lockdown will be possible and there is no encouraging sign that any medicine helping to reduce the existing atmospheric carbon stock could soon be in sight.

The only alternative is to make efficient use of the window of opportunity during which the human and economic costs of global warming remain limited to stop feeding further emissions into the existing atmospheric carbon stock and resolutely aim for a carbon-free global economy. Even though environmental concerns are growing, it seems still difficult to accept that the transition cannot be obtained for free, as illustrated by the *Gilets Jaunes* movement in France, the repeal of the carbon tax in Australia in 2016, and the withdrawal of the United States from the 2015 Paris Agreement. The aim of this article is to set out the solution recommended by economists to help address the externality of carbon emissions and launch as smooth a transition path as possible: via carbon pricing. Even though it cannot claim to be a panacea, it would enable a correction of relative prices in favour of low carbon consumption behaviour, technologies, investment and research and development.

The first section rapidly sketches the problem of carbon emissions at the global level and the challenges it raises for the decades to come. The second section presents the theoretical foundations for an efficient carbon pricing system in order to counter the usual criticisms raised against it in terms of loss of households' purchasing power and firms' competitiveness. It also explains the way in which economists are trying to establish a fair price path for carbon by weighting the welfare of the current and future generations. It ends with a brief discussion about the impact of carbon pricing on the fossil fuel prices. The third section focuses on the existing experiments with carbon pricing around the world and briefly reviews the empirical evidence regarding the effect of carbon pricing on greenhouse gas emissions on the one hand and on economic activity and employment on the other hand. Section four describes the Belgian emissions by sectors of activity in comparison to those of the European neighbours. This makes it possible to identify the sectors more at risk if ever a carbon tax were introduced in Belgium and/or in the European Union. It also insists on the difference between the emissions resulting directly from fuel combustion on national territory and those linked with our ways of producing and consuming. In this way, it gives an idea as to where to direct our efforts in the coming years to reach the ambitious climate objective of the recently installed governing coalition. Section five continues with some macroeconomic fiscal simulations of the introduction of a carbon tax in Belgium. This exercise compares the effect of a tax levied on households, on the one hand, and on firms, on the other hand. It also tries to assess the consequences of introducing a tax at the European rather than Belgian level. Finally, it assesses the importance of using the tax dividend for redistribution purposes rather than to improve the public authorities' budget deficit in order to counterbalance the negative effects of the induced shock on energy costs.

1. A brief description of the carbon problem

1.1 Atmospheric carbon and the global warming

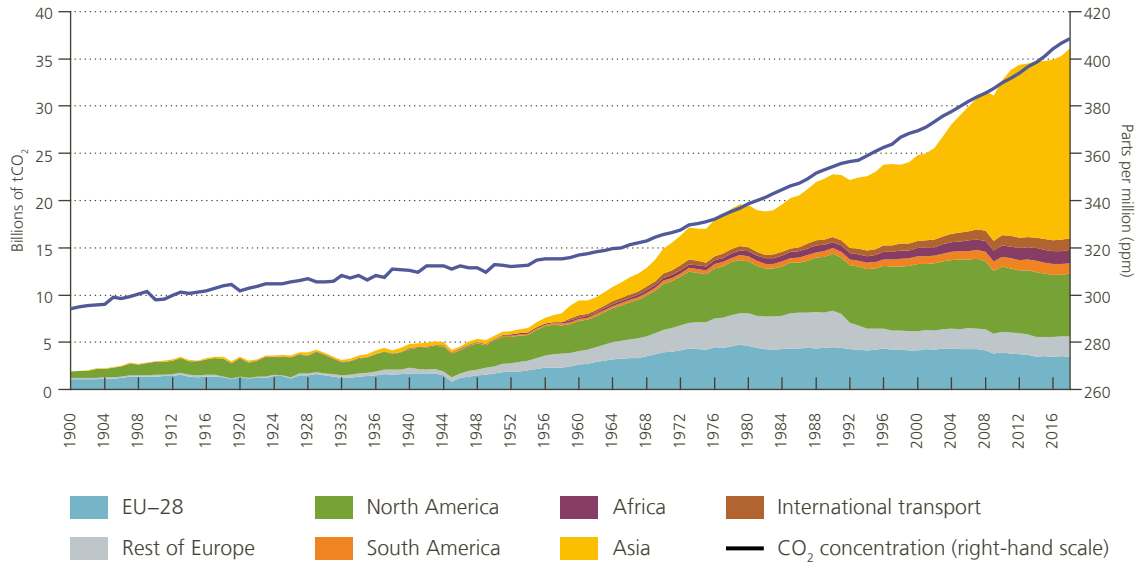
The Industrial Revolution was characterised by the transformation of energy from combustion into mechanical power that multiplied the efficiency of human labour. The continuous rate of innovation in this process made it possible to reach an incredible pace of economic development compared to previous standards. As most of the new energy requirements came from carbonated fuels, production and consumption released larger and larger quantities of carbon dioxide into the atmosphere. Carbon is a chemical element that is key for life on planet Earth. The bulk of it (about 99.9 %) is contained in the lithosphere, i.e. in rocks and sediments. The last tiny part is shared among the hydrosphere (93.4 %), the biosphere (4.8 %) and the atmosphere (1.8 %), with continuous flows between these four carbon stocks through geological activity, photosynthesis, respiration, fossilisation, etc. Given the relative size of the atmospheric carbon reserve compared to the other ones, any modification of the transfer flows between these four stocks will affect the atmosphere composition much more. This is particularly true on our human time scale, since, once released into the atmosphere, carbon is expected to stay there for a long time, between 300 and 1 000 years if natural processes alone are at work.

As pointed out by the Swedish chemist Svante Arrhenius around 1890, atmospheric carbon has the particularity of being a greenhouse gas[1], i.e. that a higher concentration of this gas in the upper atmosphere goes hand in hand with the warming of the Earth's surface. According to paleoclimate evidence, we know that over the past million years, carbon dioxide atmospheric concentration has never exceeded 300 parts per million (ppm). Before the Industrial Revolution started in the mid-1700s, the global average concentration was about 280 ppm. By the beginning of the 20th century, it had risen to 294 ppm and pursued its increase to reach 409 ppm in 2018 (see chart 1), with a correspondent rise in Earth surface temperature of 1.1°C compared to the pre-industrial era.

1 Together with methane, nitrous oxide, ozone, chlorofluorocarbons and hydrofluorocarbons. Throughout this article, we focus on carbon, which is the most important source of greenhouse gases produced from fossil fuel combustion and which lasts longest in the upper atmosphere.

Chart 1

Global yearly CO_2 emissions and average concentration of CO_2



Sources: Carbon Dioxide Information Analysis Centre, Global Carbon Project; National Oceanic and Atmospheric Administration.

With the 2015 Paris Agreement, most countries in the world agreed to keep global warming well below 2°C. This implies that concentration should be limited to about 450-480 ppm by the time we reach carbon neutrality. Given the past growth of the atmospheric carbon stock (about 2 200 gigatonnes since the mid-18th century), scientists evaluate the remaining carbon budget to be about 600 to 800 gigatonnes. Given current global emissions are around 36 gigatonnes of CO_2 (as in in 2018, see chart 1), this budget would be exhausted within 15 years if emissions continue to grow at the current rate. It goes without saying that the 2°C target has very little chance of being met without strong and radical action. Scientists meeting for the International Panel on Climate Change (IPCC) predicted in 2013, at unchanged policies, an increase of 4°C above pre-industrial levels by the end of the 21st century (IPCC, 2013)[1].

1.2 Risks and costs associated with global warming

The reason why international experts from the IPCC and other fora insist on limiting the rise in global temperature by about 2°C is that, above this threshold, they fear that we will enter into an even more uncertain era as it increases the likelihood of tipping points being reached[2]. However, the warming observed so far already has important consequences. The best-known of them is the melting of the ice stored on the North and South Poles and high mountains. This directly ends up in rising the sea level with dramatic repercussions for the millions of people living in coastal and floodable areas, notwithstanding the cost related to the potential destruction of

1 By way of comparison, during the last glaciation 20 000 years ago, the average Earth surface temperature was 6°C lower than now and Belgium was on the borderline between a region of polar desert and one of dry tundra. There was nearly no forest cover in Europe at that time.

2 Such non-linearities could be triggered by the consequences of global warming on oceanic flows or on the release of greenhouse gases stocked in the permafrost, among other things. A reversal of the Gulf Stream would lead to a drop in temperatures in Europe, while the melting of the permafrost will accelerate the greenhouse effect.

capital in terms of buildings and (harbour) infrastructure. The increase in the temperature difference between the Earth's surface and the upper atmosphere also modifies atmospheric mass fluxes, generating more frequent and more violent extreme weather events. Globally, the number of floods and other hydrological events has doubled since 2004 and quadrupled since 1980. Extreme temperatures, droughts and forest fires have more than doubled since 1980. Meteorological events, such as storms, have also doubled since 1980. This is obviously costly in terms of welfare, lives and capital losses[1]. Numerous studies prove that raising temperatures also affects productivity *per se*. Heal and Park (2013) and Park, Bangalore, Hallegate and Sandhoefner (2018) have gathered data about the impact of heatwaves or cooling systems on labour productivity and cognitive capacities. They conclude that labour productivity could drop by 2 % for each increase of 1°C above an optimum temperature, evaluated at 21°C. Kahn, Mohaddes, Ng, Pesaran, Raissi and Yang (2019) estimate that a persistent increase in the average global temperature by 0.04°C per year, in the absence of mitigation policies, would reduce global real GDP per capita by more than 7 % by 2100. All these studies emphasise that the cost of global warming will be very unevenly spread geographically, with the warmer countries, that are often the poorer ones, being the most heavily impacted.

There is no longer any room for doubt about the anthropogenic origin of the current global warming, and there is also a large consensus that the warming process is costly in terms of productivity and welfare, and that these costs will accelerate in the future. Could the growing stock of carbon dioxide in the upper atmosphere be the modern version of the demographic Malthusian trap ? The question draws the border with territories dominated by huge uncertainties. First, as mentioned above, the relationship between atmospheric carbon and global warming is subject to non-linearities and tipping points, so experts now provide statistical distributions of temperatures in correspondence to given carbon concentrations. Second, there is still a fierce debate among economists concerning the scale of the economic cost associated with global warming, a discussion which is fuelled by huge uncertainties regarding the potential of technological progress to address the issue in due time[2], on the one hand, and by the concerns about the ability, willingness and effectiveness of public authorities around the world to take action, on the other hand. Atmospheric carbon obtained from fuel combustion is produced locally but generates global damage. It is produced at a time where this damage is only weakly perceivable, and will actually be borne by future generations. Both elements are captured by what is called "the double tragedy of the horizon and of the commons". Governments therefore have to convince their citizens/electorate to accept to endorse the costs of a policy which will mostly be fruitful at a horizon behind their life expectancy and that will be shared by the whole future of humanity.

These uncertainties crystalise into risks associated with the climate change, risks that are probably neither fully understood nor correctly valued. The literature usually divides them into physical and transition risks. Physical risks arise from production factor destruction or lower productivity and the implied losses in economic activity and asset performance attributable to climate-change-related shocks and stresses. Transition towards a low-carbon economy – whether triggered by changes in policy, by shifts in consumer preferences or by technological breakthroughs – will be responsible for some Schumpeterian creative destruction, accelerating the obsolescence of carbon-intensive installed capital. Transition risks cover the losses these stranded assets could bring in terms of economic activity together with the impact on the financial system caused by asset value writedowns. Together with the above-mentioned carbon budget, physical and transition risks draw the ridge path to a safe and cost-minimised switch to a low-emission economy. Given the very slow natural decay of the stock of atmospheric carbon and the scale of current emissions, the later the transition is seriously considered and launched, the most perilous and expensive it will be.

1 For the United States only, the National Oceanic and Atmospheric Administration and the National Centers for Environmental Information evaluate that, on the basis of a 5-year moving average, the costs of climate related disasters have been multiplied by seven between the end of the 1980s and now, from US$ 15 up to 105 billion (source : Keenan, Martinez-Diaz and Moch, 2020).

2 First, through greater efficiency of fossil fuel use, second, by increased production and storage of renewable and non-carbon sources of energy and third, via the potential of carbon capture.

1.3 A brief description of the problem

Between 1990 and 2018, the area that has been the most successful in reducing its carbon dioxide emissions is the part of the European continent that does not belong to the EU28 (–44 % by 2018, see chart 1). However, this is mostly the consequence of the economic collapse following the dissolution of the former Eastern bloc rather than the outcome of some ecological concern. The reduction in emissions has been much tinier in the EU28 (–23 %), though sizeable, and the effort became more sustained since the great financial crisis. On the same time span, the industrialised countries of North America managed to limit their increase in emissions by 10 %, while emissions from the developing countries of Africa and South America doubled, and those of the rapidly growing Asian countries tripled[1]. The limited or reduced emissions in the old industrialised economies result from the combination of their progressive deindustrialisation – and manufacturing activities relocated to emerging economies[2] – with lower use of coal – the fossil fuel with the highest carbon content – in the energy mix, from 22 % and 30 % respectively in North America and Europe, down to about 17 % in both. In both areas, it has more or less been substituted by natural gas, mostly shale gas in the US. By contrast, the coal share rose from 36 % to 49 % in the Asian energy mix[3]. We draw three lessons from this birds-eye view. Firstly, as learned from the former Eastern bloc experiment, and also from the various economic crises, in the past, emissions have dropped hand in hand with value added. The challenge is therefore to reduce the first without affecting the latter. Secondly, given the global dimension of carbon emissions, it makes no sense to reduce emissions in one part of the world by shifting carbon-intensive activities towards another area. Third, managing to reduce and stop coal combustion and replace it by a less carbon-intensive fuel is the cheapest and most effective step in the path towards a low-carbon economy. Economies which have already shifted away from coal face a more abrupt step.

Several countries have announced and/or passed laws about a zero-carbon target. The European Union is committed to reducing its emissions by 40 %, or even 55 %, compared to 1990 levels within ten years and to reaching carbon neutrality by 2050. Sweden, Japan, France and the United Kingdom, among others, also target the 2050 horizon for full decarbonisation and, China, the largest emitter in absolute terms, has announced plans to approach this objective by 2060. Such programmes appear extremely ambitious: they imply that emissions would have to come down by about 7.5 % every year from now on. Just to have an idea, let us compare this number with the performance over the 2008-2018 period: on average, yearly emissions declined by 1.8 % for the EU28, 1.1 % for Germany, 1.6 % for France, 1.7 % for Belgium, 2 % for Sweden and 3 % for the United Kingdom, while Chinese emissions continued to grow at a rate of 3.2 % per year. The relative success of the United Kingdom compared with France is attributable to the fact that carbon emissions per capita are historically lower in the latter than in the former, among other reasons due to wider recourse to nuclear energy. This has made it easier for the UK to bring its emissions down by switching from coal to natural gas to generate electricity.

However, the next steps towards a low-carbon economy will be more costly and painful, requiring the gradual replacement of oil and natural gas by non-carbon energy sources (hydropower, nuclear or wind and solar energy). Japan substantially cut back its production of nuclear electricity in the aftermath of the Fukushima accident and reduced more oil-related emissions, keeping coal combustion relatively constant, so there is ample room for switching to less carbon-intensive fossil fuels as in China. Even though Belgium seems to have performed better than Germany in terms of emission reductions over the last ten years, Germany has, first of all, more "coal utilisation reserves" to reduce emissions further at a low cost, and second, it has managed to improve its energy efficiency. Both the German and Belgian efforts are nevertheless dominated by the performances of the UK and Sweden, two countries with very different initial profiles which introduced carbon-pricing mechanisms.

1 Interestingly, the reduction of emissions in Europe has been exactly offset by growing emissions in Africa and South America, so Asian economies appear as the only contributors to global emissions growth.

2 The doubling in international transport emissions reflects the internationalisation of the production process and supply chains, with Asia having become the world's main manufacturing centre.

3 All these numbers are computed from data compiled by the International Energy Agency.

Table 1

Emissions, energy and fossil fuels for some industrialised countries

(in units, unless otherwise stated)

	China	United States	Japan	Belgium	Germany	France	United Kingdom	Sweden
	2008							
Emissions								
Mtonnes CO_2	7 375	5 928	1 232	120	854	399	545	51
(index 1990 = 100)	*304.7*	*115.8*	*106.4*	*99.9*	*81.1*	*99.6*	*90.6*	*88.1*
tCO2/capita	5.45	19.53	9.59	11.16	10.53	6.42	8.76	5.48
(index 1990 = 100)	*264.9*	*96.2*	*103.0*	*92.7*	*79.1*	*90.7*	*83.3*	*81.8*
kgCO2/GDP	0.69	0.39	0.26	0.29	0.27	0.17	0.23	0.13
(index 1990 = 100)	*50.9*	*70.7*	*86.8*	*73.2*	*60.4*	*71.2*	*59.0*	*58.2*
Energy								
Mtoe	2 168	2 283	498	57	337	271	208	49
(index 1990 = 100)	*245.7*	*119.2*	*113.6*	*118.2*	*95.9*	*118.8*	*101.4*	*104.5*
Fossil fuels (in %)	90	85	83	75	80	50	90	34
of which: Coal	*78*	*29*	*28*	*11*	*30*	*9*	*19*	*14*
	2018							
Emissions								
Mtonnes CO_2	10 065	5 416	1 162	100	759	338	379	41
(index 1990 = 100)	*415.8*	*105.8*	*100.3*	*82.7*	*72.1*	*84.3*	*63.1*	*71.4*
tCO2/capita	6.92	16.21	9.32	8.54	9.65	5.34	5.81	4.24
(index 1990 = 100)	*336.7*	*79.8*	*100.1*	*71.0*	*72.5*	*75.5*	*55.2*	*63.3*
kgCO2/GDP	0.45	0.30	0.24	0.20	0.21	0.14	0.15	0.09
(index 1990 = 100)	*33.6*	*54.6*	*78.5*	51.0	50.1	*57.8*	*37.3*	*41.7*
Energy								
Mtoe	3 211	2 227	419	55	306	252	174	51
(index 1990 = 100)	*363.8*	*116.3*	*95.4*	*114.4*	*87.2*	*110.5*	*84.7*	*107.8*
Fossil fuels (in %)	88	82	88	76	78	46	79	27
of which: Coal	*70*	*18*	*31*	*8*	*29*	*8*	*6*	*16*

Sources: World Bank and Global Carbon Project; GDP per capita based on purchasing power parity (PPP), 2011 international dollars; International Energy Agency.

The fact that old industrial economies have managed to stabilise their energy requirements over the last 30 years and to modestly reduce their carbon emissions is nevertheless encouraging as it reveals that this is possible without affecting the economic growth of the most deserving cases compared to the others. In other words, it is proved that technological progress may help increase the energy efficiency of modern economies and to steadily reduce the carbon content of GDP. The challenge for the years to come is twofold. First, this movement must be strongly reinforced in the developed economies to meet their zero carbon commitments. Second, technology sharing with less-developed economies is essential for these efforts not to be ruined by the increase in emissions by rapidly growing economies.

2. Setting a price for carbon dioxide emissions to fight climate change

2.1 Elements of the debate around carbon pricing

There is a wide consensus among economists that the introduction of a carbon price mechanism is essential to addressing the global warming problem. This mechanism was introduced in Scandinavian countries thirty years ago. The European Union followed 15 years later, by launching the EU Emissions Trading System (ETS) in 2005; it is one of the first measures adopted by the European authorities in this perspective. Even today, such a mechanism is at the forefront of the policy recommendations: it has for instance been strongly advocated for the United States by prominent US economists in a famous address in January 2019[1]; it is the top recommendation of the Litterman Report (see Keenan *et al.*, Eds, 2020) to manage the climate risk in the United States.

Why do economists back a "carbon price" policy so much? They describe the problem of greenhouse gas emissions as a market failure: it is the by-product of other activities, but there is no demand for it, and therefore it is neither traded nor priced. This implies over-investment in carbon-intensive technologies, and over-consumption of fossil fuels, with greenhouse gases produced in excess with respect to what would be socially desirable. Based on the pioneering works of Arthur Pigou and Ronald Coase, environmental economists[2] state that public authorities should structure the missing market so the price of fossil fuels correctly reflects the social cost induced by their combustion. This has been popularised as the polluter-pays principle. By giving a value to the "bad" carbon emission by-product, economic agents take its production into account in their choices and energy options regarding transport, heating, electricity, etc. The goal of such Pigouvian mechanisms is not to raise money for government coffers, but to modify behaviour by setting a level playing field for market forces and restore the convergence of individual and social optima in a fully decentralised way. The effect of carbon pricing is not limited to the relative price of carbon fuels: it is also directly reflected in asset prices which are then revalued according to the carbon price exposure of firms and sectors.

However, the consensus among economists percolates with difficulty into political cenacles and the principle of carbon pricing is far from straightforward to put into place. The opponents' arguments claim, first of all, that a national carbon pricing policy would be ineffective at global level and that initiatives should be transnational[3]. Secondly, they claim that valuing carbon emissions would come at a high social and economic cost for the country introducing such a measure: local firms would lose competitiveness and market share, investors would choose to install production capacities abroad to alleviate the pricing system and households would suffer from price rises and higher unemployment. Thirdly, besides the dangers that such a mechanism would bring for economic growth and investment, it would also lead to inequalities between economic sectors and between households. Sectors are not alike, neither in terms of carbon intensity, nor regarding trade and competitiveness exposure. Fossil fuels are basic consumer goods and, as such, they make up a larger proportion of lowerincome households' consumption basket. Fourthly, some fear that a carbon pricing system would be too complex to organise and administratively costly. Finally, *a priori*, it seems hugely challenging to put a value on carbon externality.

1 This column, entitled "the Economists' Statement on Carbon Dividends" has been published simultaneously in the Wall Street Journal, Axios, the Financial Times and the Washington Post, signed by 3589 US economists, including 28 Nobel laureates, 15 former chairs of the Council of Economic Advisers and 4 former chairs of the Federal Reserve.

2 For example, Dales (1968) and Montgomery (1972).

3 This is the well-known "tragedy of the commons" leading to generalised free-riding and ending up with the complete destruction of the common good.

2.2 How to organise carbon pricing

The arguments put forward in the carbon pricing debate are important to keep in mind in order to set a pricing mechanism in a way which is both economically and politically sustainable. How should the carbon trade best be organised? A carbon price can be fixed either directly, by imposing a carbon tax trajectory, or indirectly, through the distribution of a limited number of emission permits. In the latter case, the induced scarcity gives emissions a price on the newly created secondary market where allowances can be traded[1]. Under certain conditions, including perfect information, deciding on prices or on quantities is equivalent. However, without these assumptions, fixing quantities implies that all the uncertainty related to imperfect information and foresight turns into price volatility. This was dramatically demonstrated during the great financial crisis. In a right-to-pollute system like the ETS introduced in the EU from 2005 onwards, any cyclical or structural drop in demand for permits affects the carbon price and distorts the virtuous role of the relative price signal. As belatedly recognised, it can only be restored by adjusting the volume of emission rights, as was done using the so-called Market Stability Reserve. On the contrary, if prices are set through a carbon tax system, the uncertainty moves to quantities, i.e. to the horizon at which the targeted emissions are reached.

Both types of policies have been implemented in the last three decades, as reported in section 3.1 below. For example, with the ETS, the European Union has opted for a cap-and-trade system, which was the only available option given that the Commission has no fiscal powers but it is in charge of setting competition rules. However, such a polluting permit market is only bearable for a limited number of participants, i.e. the large polluting firms. Smaller firms and households who also burn carbon fuels are left out of this pricing mechanism and so their consumption and investment behaviour is not affected by the ETS. Nowadays, sixteen[2] of the thirty-one countries concerned by the EU ETS supplement this allowance mechanism with a carbon tax to fill this gap.

In order to address the above-mentioned criticisms raised by the opponents of carbon pricing, the US Economists' Statement on Carbon Dividends calls instead for a carbon tax with no exemption regime and endowed with the following features:

– It should be paid by the buyers of fossil fuels as far upstream as possible in order to minimise its administrative cost;

– Ideally, the carbon tax should increase over time and the entire tax path should be disclosed, in order to let agents anticipate this gradual change in relative prices and adapt their behaviour and their technology mix smoothly. This is particularly important in the case of energy transition where a lot of research and development is still required, where technology diffusion may take time and new technologies are costly to put in place, demanding long-term investment plans. An obvious reason to increase the tax gradually over time is that the first efforts to reduce emissions could be not too demanding. They can be obtained by some savings measures and by switching away from the most carbon-intensive fossil fuels, like coal and lignite, to less intensive ones, like natural gas. However, the transition path towards a low-carbon economy will require at some point switching to fully decarbonated sources of energy and/or carbon capture technologies that still need to be developed;

– The tax should be revenue-neutral and all its benefits redistributed to citizens via lump-sum transfers so that the majority get back more in carbon dividends that what they pay in higher energy prices. This point

1 It is noteworthy that each time a carbon pricing mechanism has been introduced, its first consequence has been a sharp reduction of coal in the energy mix, coal being the most carbon-intensive fossil fuel. In his 2020 EEA presidential address, Per Krussel claimed that imposing a global carbon tax at the global level or banning the use of coal are two policies yielding roughly similar outcomes in terms of emission reduction and costs.

2 These countries are Finland (1990), Poland (1990), Norway (1991), Sweden (1991), Denmark (1992), Slovenia (1996), Estonia (2000), Latvia (2004), Switzerland (2008), Ireland (2010), Iceland (2010), United Kingdom (2013), Spain (2014), France (2014) and Portugal (2015). However, the sectors concerned by these taxes and their overall coverage may vary widely from one country to another (see chart 3 on this point).

is essential to oppose the counter-redistributive consequences of taxing basic necessities like fossil fuels and should help ensure the political acceptability of the system;

– Finally, a border price adjustment should be introduced to limit competitiveness losses for domestic firms and avoid relocation of energy-intensive activities. Beyond this, the goal of the border tax is mostly to give trade partners an incentive to join the carbon coalition, or the "carbon fight club" as it was nicknamed by Nobel laureate William Nordhaus. He proposed a trade tax to be applied to all goods originating from countries not taxing carbon. Such a tax would overcome the complexity of computing the carbon content of each good. In addition, the idea is that trade partners should prefer to tax carbon themselves and keep the tax dividend instead of letting the revenue from the border tax inflate the importing country's coffers.

2.3 How to decide on the starting level of the carbon price and its growth pace?

The above proposal answers all the criticisms raised earlier. The only missing point is at which level to start the tax, and at which rhythm it should increase? Climate-integrated macroeconomic models[1] are nowadays economists' central tools for producing a cost-benefit analysis of climate policies, including carbon pricing. These models have been used intensively in international fora like the Intergovernmental Group of Experts on Climate Change (IGEC) and the Intergovernmental Panel on Climate Change (IPCC). They make it possible to estimate the future economic cost implied by one tonne of carbon dioxide emitted today. Given the huge persistence of atmospheric CO_2, this cost is spread over a very long period. According to Gollier (2019), climate-integrated assessment macromodels suggest that this distribution of costs over time may average € 1200/tCO_2 within 80 years from now. Using a discount factor of 4 %[2], this amounts to € 50/tCO_2 today, which is then considered as the carbon price enabling emissions costs to be internalised. The discount factor should then be used as the yearly growth rate of the tax, which gives carbon a value of € 74 in 2030. This estimate is fully in line with the recommendations of the Report of the High-Level Commission on Carbon Prices (2017) co-chaired by Stern and Stiglitz, which estimated that carbon should be priced in the range of € 38–75/tCO_2 by 2020 and € 47–84/tCO_2 by 2030 in order to reduce emissions cost-effectively in line with the ambitions of the Paris Agreement[3].

However, there are huge uncertainties surrounding the economic models' estimates and the assessment of climate sensitivity, so these numbers should largely be viewed as indicative. They nevertheless provide a useful basis for thinking further about implementing a carbon tax and moving forward in the fight against global warming. The macromodels' uncertainty is illustrated in chart 2 which displays the interquartile and 5th-95th percentile ranges computed from the IPCC (2013) database of simulations targeting an atmospheric CO_2 concentration of 450ppm. While Gollier's proposal (indicated by the dashed blue line) seems to correspond to these simulations up until 2030, it tends to undervalue somewhat the carbon price at longer-term horizons, indicating that there is potential room to accelerate the growth rate of the carbon price. The economic and climate models' uncertainties should encourage decision-makers to adopt a very pragmatic approach. An excellent example in this regard is given by Switzerland where the carbon price path is announced together with a medium-term emission target. If the target is not reached, the price path is revised upwards.

1 Known in the literature as Integrated Assessment Macromodels (IAM). They are basically neoclassical growth models in which the greenhouse gas emissions and energy requirements are taken into account, together with the expected economic cost of global warming. They were pioneered by the 2018 Nobel laureate William Nordhaus (DICE model, 1991, 2018) and Chris Hope (PAGE model, 1993) and since then intensively used and developed by Martin Weitzman, Nicholas Stern, Per Krussel, Simon Dietz among many others.

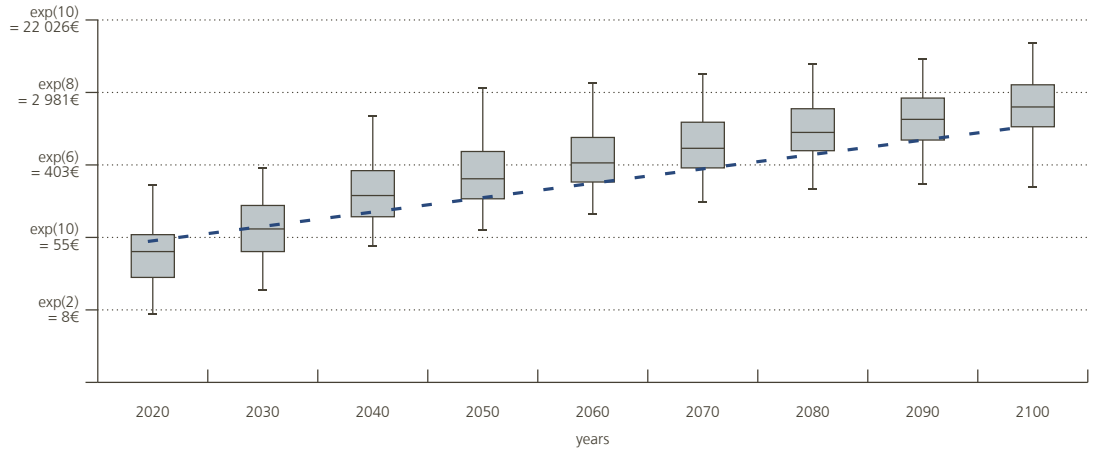
2 The discount factor to be used in these computations has been the topic of an important academic debate which is summarised in Gollier (2019, pp. 287-304), for example.

3 More recently, the Quinet-2 Commission in France computed that to reach carbon neutrality by 2050, the tax should be set at € 69 in 2020, raising by more than 11 percent each year to reach € 230 in 2030 and then more slowly at a 6 percent rate to be settled at € 750 in 2050.

Chart 2

Distributions of carbon prices as obtained from 374 simulations of IAM models in the IPCC database compatible with the Paris Agreement target of a 450ppm CO_2 concentration (log scale)

(median, interquartile range, 5th - 95th percentile range, dashed blue line: Gollier's proposal of a € 50 tax in 2020 growing at a 4 % yearly rate)



Sources: Fifth Assessment Report (AR5) of Working Group III of the Intergovernmental Panel on Climate Change (IPCC), re-assessed in real 2020 euro.

2.4 Implications of a carbon tax for fuel prices?

What does a carbon price of € 50/tCO_2 as recommended by Gollier (2019) mean in terms of fuel prices? This computation depends of the carbon emitted by the combustion of the different fossil fuels. For one liter of petrol or diesel, it would respectively amount to 11.5 and 13 eurocents, i.e. about one-fifth of the current excise duties levied in Belgium on these fuels[1]. At fuel prices prevailing in Belgium in 2020, the introduction of such a carbon tax would push up the price of petrol and diesel by about 10 %. For coal and natural gas, which are currently less taxed, prices would rise by slightly more than 20 %. Given that fossil fuels are already heavily taxed, one may wonder whether some of the excise duty could not be considered as an existing carbon tax. This is exactly the reasoning that the Swedes followed around the year 2000, when they reinforced their carbon tax mechanism. At that time, the Swedish government re-labelled some of the existing fuel taxes as carbon tax, which neutralised the effect of the carbon tax increase on the total fuel price. The future carbon tax path was clearly announced at that time. The French government used the same idea by fully offsetting the introduction of the carbon tax in 2014 by an equivalent cut in an existing indirect tax[2], allowing for a smooth transition. Again, the tax path was clearly communicated. Excise duty is often viewed as a Pigouvian tax and it may make sense to substitute one for the other. However, carbon emission is not the only externality public authorities have to consider in their global assessment. Fuel combustion is also responsible for local air pollutions and health troubles, for noise, for ground pollutions and for the wear of the road infrastructure. As discussed in section 3 below, the most important distinguishing feature of a carbon tax compared to a normal excise duty is its growth path. Nevertheless, the later a carbon price is set, the tighter the carbon budget, and the higher its introduction value – or the slope of its increasing path – should be in order to reach carbon neutrality before global temperature rises above 2°C.

1 If VAT is due on the carbon tax as it is on excise duty, such a fiscal instrument would increase taxes by about 14.5 eurocents per litre instead of 12.

2 The so-called taxe intérieure sur la consommation de produits energétiques (TICPE).

3. Some lessons from carbon pricing initiatives around the world

Even though it might not be the only explanation, there is a feeling that the very low level of excise duties and taxes on petrol and diesel in the United States – about one-fifth of the total price – plays an important role in the fact that emissions per capita are about two to three times those observed in Europe (see table 1), where taxes represent about 60 % of the consumer fuel price. Let us try to better assess how carbon prices and carbon emissions interact using the information disclosed by existing carbon pricing experiments. Since carbon taxes were first introduced at the beginning of the 1990s in Scandinavian countries, other initiatives have been taken, targeting emissions either from production or from transport. The data released on these occasions have been scrutinised by researchers in order to assess whether carbon pricing has actually helped to reduce emissions, on the one hand, and whether it has had detrimental effects on production, investment and employment, on the other hand. The results obtained are summarised in the following sub-sections after a quick glance at the carbon price initiatives around the world.

3.1 How are carbon emissions valued in 2020?

The recent report entitled "State and Trends of Carbon Pricing, 2020" by the World Bank gives an exhaustive view of the different carbon pricing schemes that have been implemented since the early nineties. In April 2020, 59 carbon pricing initiatives were in place either at the supranational, national or sub-national level[1], 29 of which are based on emission trading systems (ETS) and 30 using carbon taxes. The earlier initiatives were carbon taxes, introduced in Scandinavian countries in the 1990s. The coverage of global emissions significantly increased to some 5 % in 2005 with the introduction of the EU ETS. In 2012, Japan and California introduced their own carbon pricing mechanisms, raising the global coverage to 8 %. Since then, new initiatives have doubled the share of global carbon emissions concerned by a pricing mechanism. Less than 5 % of the emissions covered are priced within the € 38–75/tCO_2 range recommended by the Report of the High-Level Commission on Carbon Pricing (2017) and half of them are valued at less than € 10 per tCO_2. Chart 3 below scatters for most of the carbon pricing initiatives the percentage of the (locally-produced) emissions covered and the price per tCO_2, which summarises the environmental ambitions of the different political entities. In the countries with the higher price for carbon, carbon pricing devices cover between 40 and 50 % of their (locally-produced) emissions. In countries with more ambitious coverage rates, the carbon price is on average lower, even though it is still relatively high, as in the case of Norway, South Korea or British Columbia. California and Quebec have green taxation that covers the largest share of locally-produced greenhouse gas emissions, above 85 %, with a carbon tax fixed at about US$ 15/tCO_2.

3.2 Assessing the impact of carbon pricing on emissions

There are essentially two ways of assessing the potential of carbon taxes to reduce emissions: theoretical computable general equilibrium models, on the one hand, and econometric studies, on the other hand. It is noteworthy that both strands of the literature feed each other. Theoretical models make it possible to represent technology innovations and general equilibrium responses that econometric studies cannot assess. The reverse of the coin is that the results are driven by the models' assumptions/calibration which may not be fully transparent and are subject to (improved) empirical validation. A second way is to use traditional econometric methods, with the problem that there are not yet many observations from existing long-term carbon pricing experiences. However, when available, these pieces of evidence help to improve the calibration of general equilibrium models. Let us summarise here some studies in these two areas.

1 This number should double in 2021, with the introduction of the Chinese and German ETS systems.

■ A quick hint from simulations of (climate-integrated) general equilibrium models

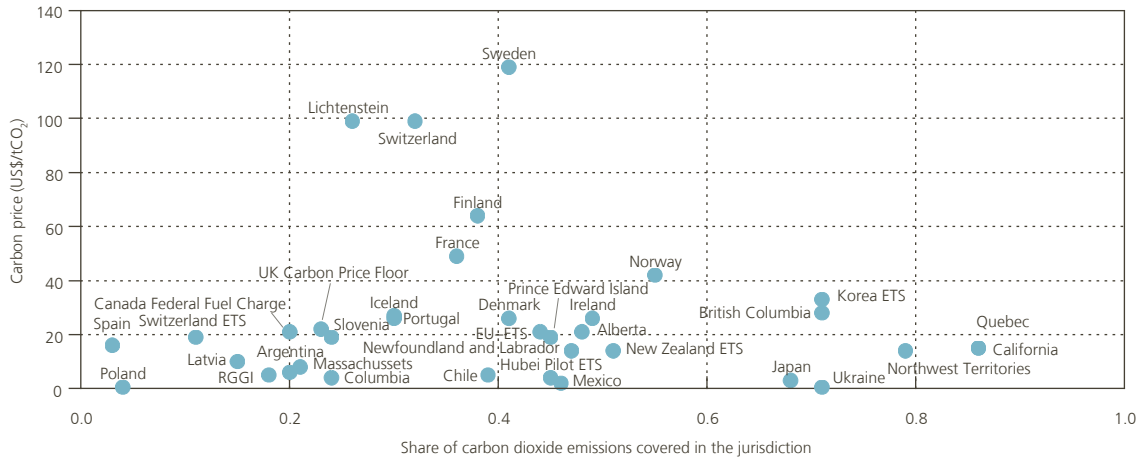
The Stanford Energy Modelling Forum has recently completed a study of the economic outcomes of introducing a carbon tax in the United States. Eleven models took part in the experiment and are briefly described in McFarland *et al*. (2018), while Barron *et al*. (2018) summarise the results. The key findings were consistent across the eleven modelling teams. First, a carbon tax is effective at reducing carbon pollution, although the structure of the tax – i.e. the price and the rate at which it rises – is important. A tax implemented in 2020 at US$ 25 per tCO_2 emitted from fossil fuels would reduce yearly emissions by about 6-18 % in the short run, mainly due to the substitution away from coal towards natural gas to produce electricity. The study also finds that the rate of increase of the carbon tax is more important than the starting price. For example, a tax of US$ 50 per tCO_2 rising by 5 % per year would cut carbon pollution by 33–56 % in 2040, while a tax of US$ 25 per tonne rising at 5 % per year would cut it by 25–50 % over the same horizon. However, the policies including a tax rising by just 1 % per year would result in only a short-term cut, but carbon pollution would remain stable at those levels. These results suggest that the most effective carbon tax might start relatively low to give taxpayers time to adjust but should increase rapidly over time.

■ Some lessons from applied experience

Observing just the trend in CO_2 emissions before and after the introduction of such taxes may already give an *a priori* view of the effectiveness of the policy, even though it does not enable the exact role played by the tax to be assessed. Let us consider four examples here, two about carbon taxes targeted to the electricity generation sector, and two about taxes more geared towards transport and heating. In the United Kingdom, the Carbon Price Support (CPS) introduced in 2013 tops up the EU ETS allowance prices for power firms in order to reach a carbon floor price target fixed by the government. As a result, coal-generated emissions dropped by 78 %, from 140 $MtCO_2$ in 2013 to 31 $MtCO_2$ in 2018. Australia imposed a carbon tax in July 2012, covering fuels used to generate electricity and several other sectors, although not motor fuels for passenger transport. The tax was rescinded in July 2014 when a new national government repealed it. Therefore, it provides a test case for looking at changes when the tax began and again when it ended. Between July 2012 and July 2014, the combined emissions of the sectors covered dropped by 12.5 Mt CO_2, and rose again by 7.5 Mt CO_2 between July 2014 to July 2015 (Nadel, 2016). As for the United Kingdom, the biggest share of the drop in emissions

Chart 3

Carbon pricing initiatives around the world: carbon prices in 2020 US$ (as of April 1) and shares of the covered emissions



Source: World Bank.

(and rise after the tax was abandoned), came from the switch from (respectively to) coal to (respectively from) alternative fuels to produce electricity.

The case of the British Columbia (Canada) carbon tax is interesting compared to the two above-mentioned ones, as it does not rely on the production of electricity[1], but covers 70 % of the emissions generated by production and transport. The carbon tax started in 2008 at C$ 10 per tCO_2, scheduled to increase by C$ 5 per year until it reaches C$ 50 per tonne in 2021. The tax is applied uniformly to all fossil fuels burned within its border[2]. It is one of the carbon tax initiatives with the highest coverage among the carbon pricing experiences listed by the World Bank. Up to now, given the existing federal taxes, the CO_2 tax has raised the overall excise duty on petrol by about one-fifth. In 2018, the tax brought in over C$ 1 billion – over five percent of provincial tax collections – and all the revenue is returned to businesses and households through a combination of tax rate reductions, grants to businesses and households, and other business tax breaks. In a simple exercise, Komanoff and Gordon (2015) compare the pre- and post-tax periods (respectively 2000-2007 and 2008-2013) in British Columbia and the rest of Canada. They find that, excluding the electricity sector, the province's emissions declined by 6.1 % while emissions in the rest of Canada rose by 3.5 %, i.e. a difference of 9.6 percentage points. Emissions per capita and per dollar of GDP are respectively 9.2 and 12.4 % lower in British Columbia. For Sweden, Metcalf (2019) reports that the carbon tax rate, mostly focused on transport-generated emissions, has been multiplied by 4.7 since the introduction of the carbon tax, while tax revenues were only 3.4 times larger in 2017 than in 1994 (first year of available data), displaying an effective reduction in emissions. Still for Sweden, Andersson (2019) evaluates that the per capita emissions from transport were 15 % lower in 2005 than what they would have been in the absence of the carbon tax. Such outcomes are encouraging since emissions from transport are amongst the most challenging to reduce[3].

Besides such simple comparative analysis exercises, other studies attempt to identify the role of the tax itself on the demand for fossil fuels and emissions reduction. In this regard, several authors compare how demand for petrol reacts to a price change depending on whether it is dictated by taxation, on the one hand, or by the market, on the other hand. Among others, Davis and Kilian (2011), Li, Linn, and Muehlegger (2014), Antweiler and Gulati (2016), Rivers and Schaufele (2015) or Andersson (2019), respectively for the United States (first two), British Columbia (next two) and Sweden (last), find that demand for petrol reacts between two and four times more to an increase in fuel taxes than to a market price increase. The reason is that the tax is expected to last (and even increase steadily in British Columbia and Sweden), while the fuel price itself is known to fluctuate widely with the conditions on the oil market. The Andersson (2019) result is worth pointing out as it is the only one related to a European market, whereas the other studies focus on the United States and Canada, where petrol taxes are significantly lower, making the tax-inclusive price much more volatile.

Other studies have focused on the emissions due to the production sector and use firm-level micro data. For the period preceding the introduction of the EU ETS, two studies use observations related to tax schemes targeting firms' use of fossil fuels decided in the United Kingdom and in Sweden respectively. For the United Kingdom, Martin, de Preux, and Wagner (2014) focus on the Climate Change Levy (CCL) introduced in 2001. Over the analysis period, the CCL added 15 % to the energy bill of a typical UK business, with a discount granted up to 80 % of the tax rate for plants in selected energy-intensive industries. The CCL system provides a unique opportunity to study the effects of a carbon tax in an industrialised economy by comparison of outcomes between plants subject to the full tax and plants that paid only 20 % of the tax. Focusing on the first three years following its introduction in 2001[4], the authors use longitudinal data on manufacturing plants to estimate the impact of the CCL on energy use, emissions and economic performance. They find that the carbon tax had a strong negative impact on firms' average emissions, which fell by 8.4 % over the three-year period analysed.

1 Almost 100 % of the electricity produced in British Columbia is of hydraulic origin, which is not the case for the rest of Canada.

2 The only major exemptions are inter-jurisdictional shipping and flights, i.e. journeys between British Columbia and the rest of Canada.

3 This is evidenced for Belgium in table 3 below, where households' transport emissions are shown to have risen strongly between 2000 and 2018, while most of the other items declined or stabilised.

4 The reason is to avoid overlap with the EU-ETS that where introduced in 2005.

Brannlund, Lundgren and Marklund (2014) provide another firm-level study applied over a longer time span, for Sweden. Even though the Swedish CO_2 tax is mostly geared to transport, the industrial sector saw the carbon price rise from zero to € 20/tCO_2 from 1991 onwards[1], but with a system of sector-related exemptions that come down over time. Brannlund *et al*. (2014) use micro data at the firm level for the years 1990-2004[2]. With the series of the actual effective tax rate per firm at hand, they distinguished the effect of the change in fossil fuel price from changes in the effective tax rate. They find that firms' carbon intensity performance responds to changes both in the tax and in the fuel price, with a higher sensitivity to the tax, for the same reasons as mentioned above for demand for petrol. They compute that manufacturing output rose by 35 % from 1990 to 2004 while related emissions fell by 10 %. The biggest reductions in emission intensity are observed in the electricity, chemicals and motor vehicles sectors, which are among the heaviest emitters.

De Jonghe, Mulier and Schepens (2020) use the database of the firms subject to the EU ETS. Their estimation strategy is based on the structural break induced by the recent change in the allocation of allowances. In May 2017, the announcement of a credible revision of the Market Stability Reserve mechanism aimed at dealing with the excess of carbon emission allowances on the market led to a sharp increase in the price of carbon, from around € 5 at the date of announcement, to above € 20 from mid-2018 onwards. The authors use the difference-in-difference methodology and compare, within the same NACE 2-digit code sector, firms that were *ex ante* in strong shortage of allowances to firms *ex ante* in low or no shortage both three years before (2014-2016) and three years after (2017-2019) the tightening of the regulatory mechanism. They show that the more polluting firms adapted to rising carbon prices: on average, compared to less polluting firms, they reduced significantly more their emissions by 5, 9 and 11 % respectively over the three ensuing years. Furthermore, this reaction is stronger in sectors given fewer free allowances, i.e. where the cost constraint is more binding. It is noteworthy that heavy-polluting firms adapt partially by taking control of firms with a cleaner technology within the EU (extended to Norway, Switzerland and UK). In line with such results, Dussaux (2020) evaluates from a dataset covering 8 000 French manufacturing firms between 2001 and 2016 that a 10 % increase in the price of energy via a carbon tax causes a 6 % decline in energy use and a 9 % drop in carbon emissions.

3.3 Assessing the impact of carbon pricing on economic growth and employment

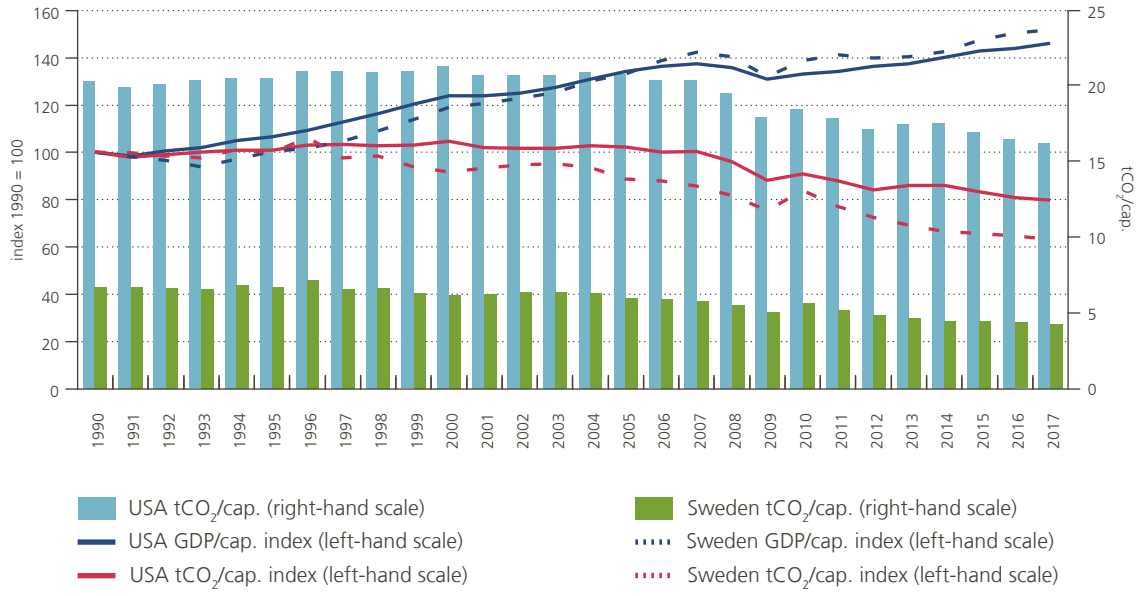
The economic theory view that carbon taxes represent a cost-effective approach to reducing emissions seems to be confirmed by the above case studies. However, many policy-makers and citizens still fear that they might impose a large burden on the economy. Still, some economic studies, such as Andersen *et al*. (2007), point that modest carbon taxes are unlikely to cause significant negative impacts on economic activity. According to the so-called "double dividend hypothesis", some claim that it might even have a positive effect on economic output: as income taxes produce price distortions and reduce economic activity, lowering income taxes thanks to the dividend of a carbon tax could at the same time reduce emissions and raise total economic output (see, for example, Pearce, 1991, and Tullock, 1967). The conclusion of the theoretical models used by the Stanford Emerging Modelling Forum project (see section 3.2 above) confirms the "weak" double dividend hypothesis that revenue recycling can compensate for economic losses from a carbon tax, but not the "strong" double dividend hypothesis that the tax generates net economic growth: "*We find robust evidence that even the most ambitious carbon tax is consistent with long-term positive economic growth, near baseline rates, not even counting the growth benefits of a less-disrupted climate or lower ambient air pollution.*" This outcome is also reached by Beck *et al*. (2015) in a general equilibrium model calibrated for British Columbia.

Besides such purely model-driven analysis, the various fiscal experiments listed above have produced data that make it possible to assess which one of the two opposed views is empirically validated. First of all, one may take a naive view and consider whether the economies with the heaviest carbon taxes seem to suffer particularly. Let us just consider two extremes. Between 1990 and 2017, GDP per capita grew by 46 % in the United States

1 At 2009 prices.
2 Like Martin *et al*. (2014), the authors also stop the analysis in 2004 to avoid any overlap with the introduction of EU-ETS.

Chart 4

Economic and carbon performances of Sweden compared to the USA 1990-2017



Sources: World Bank and Global Carbon Project; GDP per capita based on purchasing power parity (PPP), 2011 international dollars.

and by 52 % in Sweden, as illustrated in chart 4[1]. At first sight, there is little reason to think that the Swedish economy suffered strongly from the introduction of the most aggressive carbon tax scheme in 1991 and from its EU ETS membership since 2005. Its carbon pricing policy seems to have been fruitful in terms of emission reductions. While Sweden ranked among the lowest emitters among industrialised countries in 1990, with 6.7 tCO_2 per person, it had managed to reduce it by more than one-third at the 2017 horizon, with absolute emissions dropping by one-fourth. Over the same time span, US emissions continued to rise by 5 % in absolute terms, while emissions per capita slowly declined from 20 to 16 tCO_2.

Few studies focus on the relationship between the introduction of a carbon tax and economic activity. However, some of the above-cited articles confirm that taxing carbon dioxide has not led to any sort of economic collapse. For example, in the case of the United Kingdom's CCL experience, Martin *et al*. (2014) find no statistically significant impact for employment, revenue or manufacturing plant exit. Besides, they find a (statistically insignificant) production factor substitution effect from energy towards labour. Regarding the British Columbia experiment, Metcalf (2019) uses the same difference-in-difference methodology as for emissions, simply adding control variables to cover the sectoral composition of economic activity. Without these composition variables, the effect of the carbon tax on economic activity is insignificant, while, controlling for this aspect, it turns out to be significantly positive. For Sweden, Andersson (2019) clearly points towards the neutrality of the transport carbon tax with respect to economic activity. In their econometric study of firms subject to the EU ETS and their reaction after the strengthening of the system in 2017, De Jonghe *et al*. (2020) find no significant impact on firms' operating revenue for the three years of data availability. Metcalf and Stock (2020) run dynamic estimations over the period 1985-2018 for the 16 countries belonging to the EU ETS which, in this period, adopted a carbon tax to supplement the cap-and-trade mechanism. The effect they find regarding of the "carbon tax shock" on GDP is positive for most of their specifications and at all horizons, although not statistically significant.

1 In real terms, using Purchasing Power parity for a meaningful international comparison.

Yamazaki (2017) focuses on the labour market effects of the British Columbia carbon tax with a partial equilibrium demand model for labour as a function of the carbon tax. He estimates a labour demand function using industry-level data from 2001 to 2013 on employment across provinces, controlling for industry, province, and time-fixed effects as well as the emissions intensity and trade intensity of an industry. He finds negative employment effects for emissions-intensive and trade-exposed sectors but positive effects for other sectors and for the overall labour market. In particular, he estimates a 30 % drop in employment in basic chemical manufacturing but gains in other sectors that more than make up for it. Yamazaki finds evidence that the labour supply effect is stronger than the demand effect, causing the wage rate to decline. Similarly, in the above-cited study on French manufacturing firms, Dussaux (2020) finds that increases in the price of energy mostly reallocate employment between firms and sectors, from the more to the less energy-intensive ones, but does not lead to any net employment losses. Such outcomes point up the important role complementary labour market policies can play to ease the implied employment reallocations and minimise the associated social costs. Bijnens, Hutchinson, Konings and Saint-Guilhem (2020) raise the important point that with a more stringent European-wide carbon policy, some countries could suffer more than others due to their sectoral composition and would not necessarily manage to absorb the energy price shock as smoothly as stated by the previous studies. They also insist that the financial constraint faced by firms strongly conditions their reaction to the shock.

4. CO_2 emissions in and for Belgium

The most obvious way of thinking about Belgian carbon emissions is CO_2 emissions generated within Belgian territory by companies during their production processes or by households when consuming. But these territorial emissions do not correspond to the global emissions induced by Belgium, as one also needs to take into account emissions which are incorporated into Belgian imports and exports. In this section both concepts are discussed.

4.1 Carbon emissions in Belgium

In 2018, some 100 million tonnes of CO_2 were emitted in Belgium, which, according to the International Energy Agency (IEA), accounted for 0.27 % of global carbon emissions. As a reference, World Bank statistics show that, in that year, Belgium hosted 0.15 % of the world population, while the Belgian economy accounted for 0.46 % of global GDP[1]. While emissions per capita are therefore larger than the world average, Belgium is relatively more carbon-efficient than the world as a whole per unit of value added generated.

Over the period 2000-2018, Belgian carbon emissions fell by 25 %. Over the whole period, there was a gradual decline, although, since 2014, no clear further decrease has been observed. Emissions of companies, accounting for almost three-quarters of total emissions, dropped by 29 %, while the reduction of household emissions remained more limited, at some 12 %.

As far as enterprises are concerned, large differences are found between branches of activity. In industry and market services, emissions dropped by more than 30 %, but, in 2018, both branches taken together still accounted for about two-thirds of our country's total emissions. The decrease remained more limited in agriculture and construction, while emissions even rose slightly in non-market services. CO_2 emissions of households declined considerably for heating and cooling purposes, but for transport, emissions largely increased.

The carbon emissions of companies are of course linked to their economic activity, while those of households depend amongst other reasons on the population figures. Therefore, it is useful to calculate emission intensities.

1 Gross domestic product (GDP) expressed in current international dollars, corrected to eliminate the effects of the differences in price levels between countries (purchasing power parity or PPP).

Table 2

CO_2 emissions in Belgium

	2018 (millions of tonnes)	Evolution 2000-2018 (in % change)
Enterprises	74	–29.1
Agriculture	2	–12.6
Industry	50	–30.1
Construction	2	–8.1
Market services	16	–34.6
Non-market services	4	3.5
Households	26	–11.5
Heating and cooling	13	–28.8
Transport	11	31.2
Other [1]	2	–31.3
Total	100	–25.2

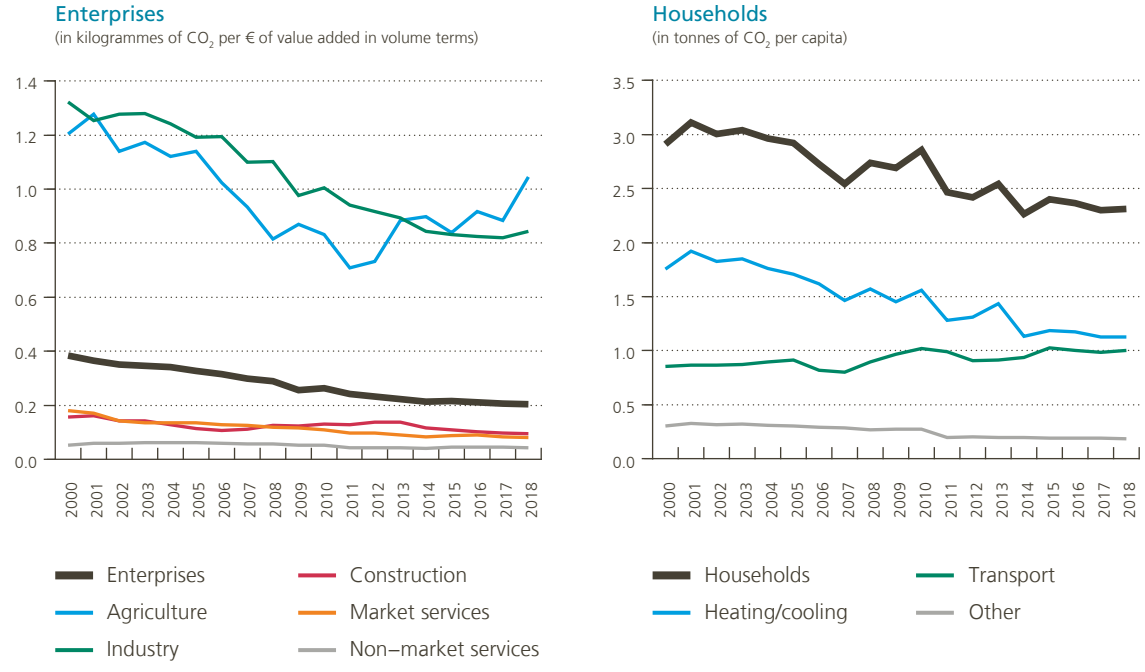
Source: EC.

1 Includes emissions from working machinery such as lawn mowers, hedge clippers and other gardening equipment, for example.

For companies these reflect the carbon content of one unit of value added produced, while household emissions can be expressed per capita. The CO_2 intensity of companies has considerably decreased. Over the period under consideration, it was reduced by almost half, as the above-mentioned drop in carbon emissions materialised, while value added in volume terms rose by one-third. A downward trend is observed in all large branches of

Chart 5

Carbon intensity of enterprises and households in Belgium



Source: EC.

activity, with the notable exception of agriculture. In that branch, carbon intensity fell sharply until 2011, but since then, a clear upward movement has been observed, reflecting a renewed increase in CO_2 emissions. Nevertheless, carbon intensity in agriculture was still some 15 % lower in 2018 compared to 2000. In non-market services, a comparable drop is observed after a gradual reduction over the whole period considered. In industry and construction, the decline reached almost 40 % and even 55 % in market services.

While some economic activities, like manufacturing, are very energy-intensive and therefore lead to large CO_2 emissions, others are intrinsically less polluting. Comparing directly the carbon intensity of branches of activity is therefore not appropriate. However, the carbon intensity of the Belgian branches, calculated as total CO_2 emissions per unit of value added at current prices, can be much more meaningfully compared to that of their European counterparts. Of course, even at very detailed sectoral breakdowns, one can still observe differences in the specific activities conducted in a given branch in two countries, implying that the results of this exercise still need to be considered with some caution.

According to the available data, in 2018, the average carbon intensity of the Belgian economy was largely comparable to that of the EU as a whole and to that of Germany and the Netherlands. By contrast, the French economy was on average less carbon-intensive. While the Belgian economy produced considerably less CO_2 per unit of value added than Bulgaria, the most carbon-intensive country in the EU, it was some 70 % more CO_2-intensive than Sweden, where carbon intensity is lowest. These observations hold in general for all large branches of activity, with the exception of agriculture, for which carbon emissions per unit of value added in Belgium are more than twice as high as on average in the EU, and clearly higher than in the three neighbouring countries. In industry, construction and non-market services, carbon intensity is slightly higher than on average in the EU, while in market services, it is somewhat lower. Nevertheless, in all large branches, a considerable gap is found with respect to the most CO_2-efficient country. This conclusion is confirmed at a more detailed level of economic activity. In 2017, Belgian carbon intensity was higher than on average in the EU in 34 out of 63 branches. In none of the 63 branches was our country the most emission-efficient and, in all branches, the gap with the least carbon-intensive country was large.

The above-mentioned reduction of CO_2 emissions of households was achieved although the population rose by 11 % over the 2000-2018 period. As a result, carbon intensity of households declined by 21 %. Carbon intensity of heating and cooling dropped by 36 %. By contrast, CO_2 intensity of transport increased by 18 % over the whole period, but since 2010 no further worsening has been observed. According to the available data, Belgian households are clearly less carbon-efficient than the EU average. This is mainly due to its mediocre performance regarding heating and cooling[1]. The carbon intensity of transport of Belgian households is comparable to that of their EU counterparts. The results for both companies and households at least seem to indicate that it should in principle be possible to (further) reduce the carbon intensity of their activities in Belgium, by using existing, more emission-efficient techniques.

4.2 Carbon footprint of Belgium

The emissions produced within the Belgian territory do not reflect Belgium's total contribution to worldwide carbon emissions. Indeed, in order to fully evaluate the burden of Belgium on global warming, one must also take into account CO_2 emissions generated abroad in order to produce goods and services that are used or consumed by domestic companies and households. On the other hand, one must correct for the emissions made for locally-produced goods and services which are later exported and finally used elsewhere.

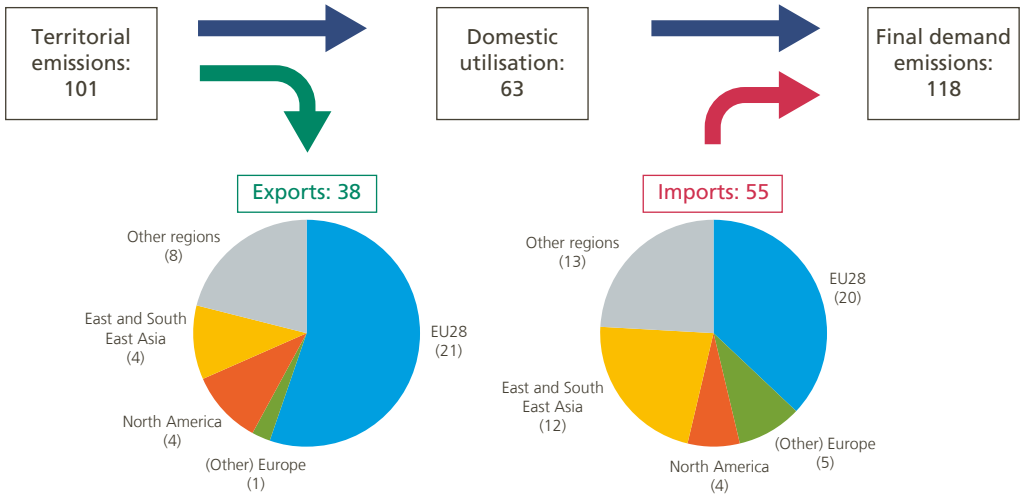
To this end, the environmental accounts, compiled by the OECD amongst others, are very useful. Indeed, by using international input-output data at sectoral level, these accounts attribute CO_2 emissions to the countries where

1 For more views on emissions related to the heating/cooling of buildings and the potential financial challenges, please refer to Van Tendeloo (2020).

Chart 6

Explicit and implicit carbon emissions of Belgium

(in million of tonnes of CO_2, 2015)



Source: OECD.

final demand is situated. This process can be illustrated by using the most recently available data for Belgium, with respect to 2015. In that year, 101 million tonnes of CO_2 were emitted in Belgium, of which 63 million were linked to domestically-used goods and services. The remaining 38 million tonnes were emitted to produce goods and services destined for foreign demand. While those "exported" emissions have to be attributed to the country where final consumer use takes place, the Belgian carbon footprint includes the 55 million tonnes of CO_2 emissions generated abroad in order to produce goods and services which are imported and finally used or consumed in Belgium. So, while Belgium emitted 101 million tonnes of CO_2 itself, its total final demand implied total CO_2 emissions of 118 million tonnes. The total carbon footprint of our country is therefore not equal to the 0.27 % of global emissions if just territorial emissions are taken into account, but accounts for 0.37 % of worldwide CO_2 emissions.

Of the total implicitly imported amount of 55 million tonnes of CO_2, 20 million tonnes (37 %) stems from other EU countries. Some 5 million tonnes were emitted in other non-EU European countries. About 12 million tonnes originate from East and South-East Asia, 8 million tonnes of which come from China. North America, and in particular the United States, accounts for another 4 million tonnes of imported CO_2. Of the total implicitly exported carbon emissions of 38 million tonnes, 21 million tonnes are implied in exports to other EU countries. North America and East and South-East Asia both account for some 4 million tonnes.

5. Assessing the macroeconomic effect of introducing a carbon tax in Belgium

In this section, an attempt is made to estimate the possible impact of a carbon tax of € 50 per tonne of CO_2 rising by 4 % every year, following the Gollier (2019) proposal. Note that in these exercises, for the sake of simplicity, we follow our Dutch colleagues (Hebbink *et al*., 2018) and simply impose the carbon tax on top of existing ones (excise duties, VAT, EU ETS)[1]. In a first step, we evaluate the burden that, *ex ante*, such a tax would represent for households and enterprises, the latter broken down by branch of activity, and compare it to the EU on average and our neighbouring countries. In a second approach, we will use the Bank's econometric models, in order to assess the impact of a carbon tax on the Belgian economy under different assumptions.

5.1 The (potential) implied burden of a carbon tax in Belgium and neighbouring countries

In 2018, a total of 3 701 million tonnes of CO_2 were emitted in the EU. *Ceteris paribus*, an EU-wide imposed tax of € 50 per tonne on top of the EU ETS mechanism would therefore have yielded € 185 billion[2]. Pricing CO_2 emissions generated in Belgium would have cost firms and households € 5 billion, or 1.09 % of GDP. So, the total cost for our country would have been slightly lower than on average in the EU (1.16 % of GDP). The total tax burden would have been lowest in Sweden (0.56 %) and highest in Bulgaria (3.90 %). The calculated figures show a clear East-West divide inside the EU, reflecting technological gaps and differences in energy mixes between EU Member States. Reflecting their contribution to total Belgian CO_2 emissions, Belgian enterprises would have had to pay € 3.75 billion. The cost for companies in the market sector would have been € 3.5 billion, representing 1.12 % of their total value added.

In most services branches, the impact of a carbon tax would remain very limited, around or below 0.3 % of value added. Transport activities are, not unexpectedly, notable exceptions. That is particularly the case for air transport services, for which a carbon tax of € 50 per tonne of CO_2 emitted would imply a cost of 43 % of their value added. For manufacturing as a whole, the impact would be around 3 % of value added, but large differences are found. While the cost would be limited to 0.14 % of value added for the manufacture of chemicals and of electronic products, it would rise to 23 % of value added for the manufacture of refined petroleum. The impact would have been about 0.46 % in construction, but it would have been clearly higher in agriculture (almost 5 %) and, in particular, in the production of electricity (14.5 % of value added).

By using the same calculation method for all EU countries, the burden for Belgian companies can be estimated from an international perspective. For the market sector as a whole, a carbon tax would hurt Belgian firms somewhat less than their counterparts in the rest of the EU, in Germany and the Netherlands, while French companies would pay relatively less. The fact that the relative burden for all Belgian firms taken together would be close to the EU-average hides the big differences per branch of activity. In manufacturing in particular, the cost for Belgian companies turns out to be clearly higher than for competitors in most European countries. By contrast, firms active in transport activities or the production of electricity[3] would pay a carbon tax, expressed as a percentage of value added, below that in Germany, the Netherlands and in the EU as a whole.

1 Remember hower from sections 2 and 3 above that no government so far has introduced the tax so abruptly. Most of the time, it substitutes out part of existing excise duties and the sectors most exposed to carbon prices and international competition benefit from exemptions. The exercise examined here is rather radical. It nevertheless helps to fix ideas and to understand the order of magnitudes at stake. Reactions to the initial impulse being mostly linear, the reader can easily assess the effects of introducing the tax at a lower level.

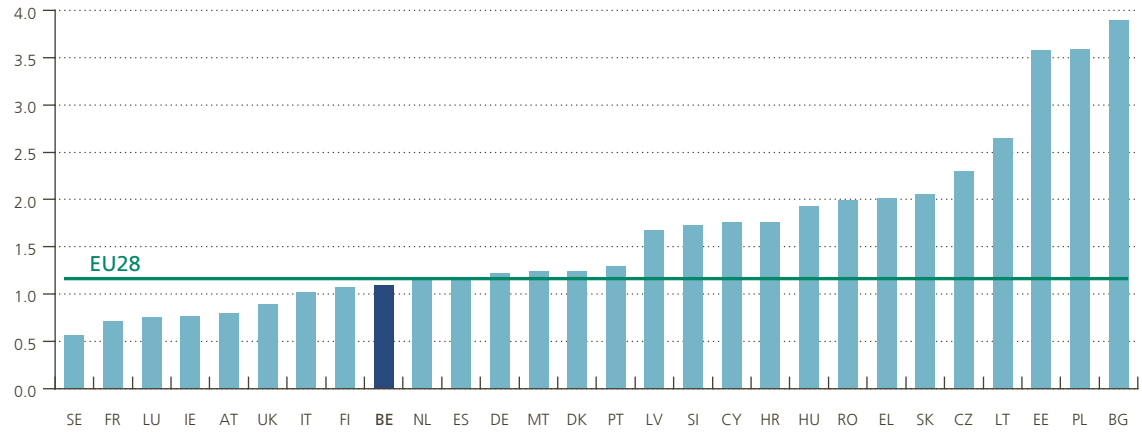
2 Note that 11 EU countries have already introduced a carbon tax with different amounts and coverages. To be perfectly fair, this should have been taken into account and, for these countries, the tax should have been increased only for the difference between the existing and the € 50/tCO_2 considered here. In other words, the comparison made here is biased in favour of Belgium where no carbon tax mechanism has yet been formally introduced.

3 It should nevertheless be noted that, given the current plan to phase out nuclear power plants, emissions from electricity generation might increase in subsequent years if the energy mix relies more heavily on the use of fossil fuel (e.g. with natural gas production units).

Chart 7

Total cost of an EU tax of € 50 per tonne of CO_2

(in % of GDP, 2018)

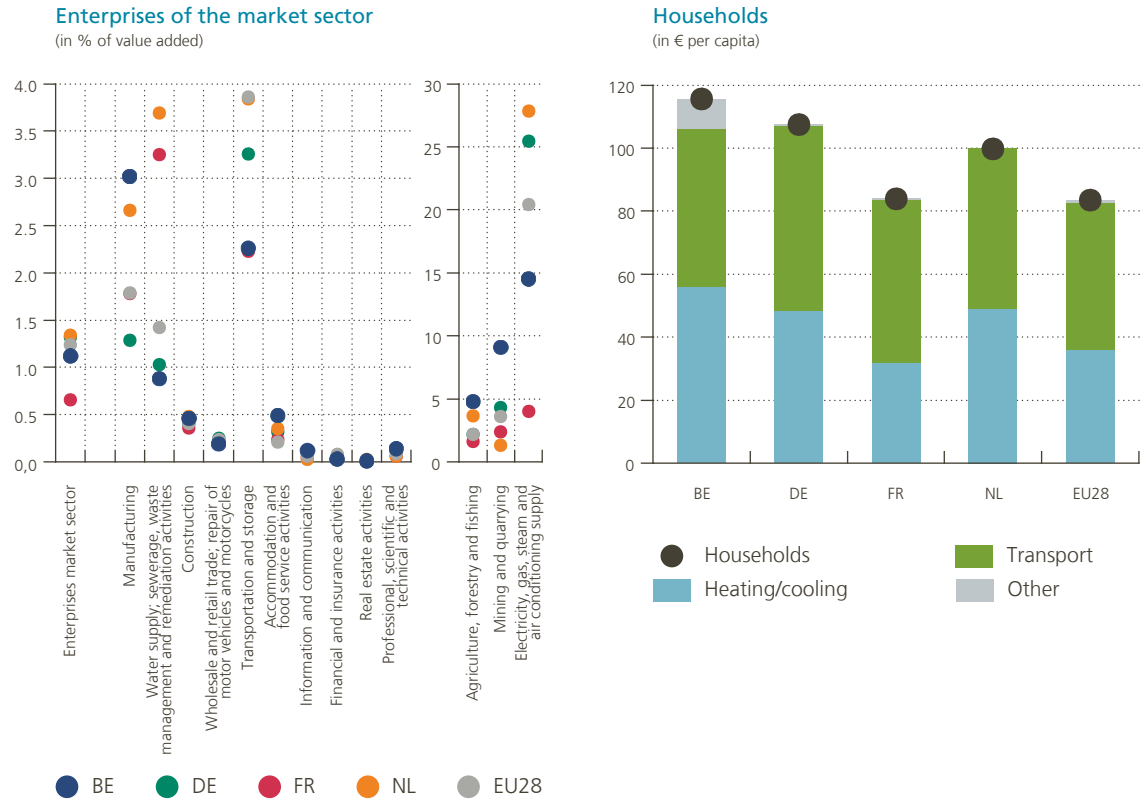


Sources: EC, own calculations.

Chart 8

Cost of an EU tax of € 50 per tonne of CO_2 for enterprises and households

(2018)



Sources: EC, own calculations.

In this scenario, Belgian households would in total have paid € 1.25 billion, which amounts to € 116 per person in the population. This cost is high from a European perspective: this tax would on average cost € 84 per person in the EU, and only in two countries – i.e. Luxembourg (€ 148) and Ireland (€ 132) –would households have to pay more than in our country. Both transport and (in particular) heating and cooling appear to be relatively polluting in Belgium.

5.2 Assessing the macroeconomic effect of introducing a carbon tax in Belgium

Macroeconomic general equilibrium models in use in central banks are certainly not best equipped to simulate the macroeconomic implications of introducing a carbon tax along the lines presented in section 2. Such models are mostly dedicated to the dynamic analysis of fiscal and monetary policies along the business cycle and their sophistication in these dimensions is obtained at the cost of other simplifying assumptions which are detrimental for the topic considered here. First, they are built on the assumption of "representative agents" – one representative household, one representative firm – and they consider only one single final good that can be either consumed or invested. This prevents them from studying the consequences of the introduction of a CO_2 tax on the statistical distribution of households' revenues, the reallocation of economic activity among the production sectors, and the changes in consumer behaviour and investment choices driven by relative prices, as expected from a Pigouvian tax. Second, they consider only one production technology and few of them consider energy and fossil fuels among the production factors. This implies that, in such models, once the introduction of the tax is announced, firms cannot decide to invest in a low-carbon technology or in the research and development required to obtain it in the medium to long run. Consequently, these models cannot assess the cost of stranded assets implied by the transition away from carbon-intensive technologies. Even the elasticity of substitution between energy and other production factors is not reliable: by default, pure complementarity is assumed. Furthermore, such an elasticity is difficult to estimate at aggregate level and, as discussed at length above, estimates based on past energy price fluctuations would probably underrate the actual reaction of firms to a permanent tax introduction. Third, they do not take into consideration the possibility for carbon-intensive activities to relocate.

Even though these shortcomings certainly disqualify these models from studying the long-run consequences of introducing such a tax[1], they may nevertheless prove useful to think about some important transmission channels of this tax to the real and nominal sides of the economy in the short to medium run. For these reasons, the simulations are mostly indicative, and the results are not reported beyond a five-year horizon. As the energy intensity and energy mix are fixed, they most probably describe a worst-case scenario. The different econometric studies mentioned in sections 3.2 and 3.3 unanimously find that firms and households adapt their fossil fuel combustion when facing carbon pricing much more quickly than within the five years. A reduction of the share of fossil fuels in the consumer basket or in firms' marginal costs would limit the effect of the tax on prices, while substituting from taxed energy sources should favour investment and employment. However, the fact that models disregard the possibilities of firms' relocation might somewhat tip the balance.

In the following simulations, various scenarios for introducing a carbon tax in Belgium are assessed through the lens of the National Bank of Belgium's workhorse model "Noname", which is described in Jeanfils and Burggraeve (2005). Noname is a medium-sized Neo-Keynesian model, where demand is driven by the business cycle in the short to medium run and by fundamental supply-side parameters (such as productivity, population growth, etc.) in the medium to long run. Its equation specifications try to strike a balance between economic theory and data-matching, while taking into account that optimal behaviour can only be reached in a context of costly adjustment processes that take time. Households provide labour to firms, which in turn generate labour income to consume or save. Profit-maximising firms import intermediate goods and set prices as a mark-up over costs, after which their goods and services can be bought by households (private consumption and housing

1 Macroeconomists are developing new tools to better assess this dimension, such as dynamic stochastic general equilibrium models together with the environmental bloc of climate-integrated assessment macromodels.

investment), domestic firms (investment) and firms abroad (exports). The model is supplemented with a complete income framework that traces both primary income and redistributive transfers between households, firms, government and the rest of the world, in order to calculate disposable income and net financial surplus for each of the domestic sectors. The model has an exogenous monetary policy, but endogenous fiscal policy through a set of adaptable policy rates for tax and social security contributions that generate government revenue while it simultaneously traces the main social transfers to households and other government expenditure.

The following scenarios will shed some light on how such a tax of € 50/tCO_2, subsequently rising by 4 % every year as proposed by Gollier (2019), would affect the Belgian economy. We illustrate different transmission channels through which the tax would affect the main macroeconomic variables by changing our focus along three different axes. Is the tax paid by households, by firms or by both sectors ? Is the tax introduced in Belgium alone or is it decided upon at European level ? And finally, are the newly generated tax revenues simply used by the government to reduce its outstanding debt or will the government try to mitigate the negative economic effects through additional transfers and tax rebates ? The simulation results for the different scenarios are displayed in table 3 and show how the main macroeconomic variables of the Belgian economy react to the tax respectively one, three and five years after its introduction.

- Introducing a carbon tax, in Belgium alone, levied on Belgian households, without tax refunds

In a **first scenario**, we consider the case of the Belgian government collecting € 1.25 billion through a carbon tax levied on household fuel combustion through the end-user price of petrol, diesel, heating oil and natural gas. In this scenario, the introduction of the carbon tax is a purely Belgian measure, not followed by governments of other Member States of the European Union. Moreover, the Belgian government will use the proceeds of this tax to accelerate its debt reduction and not to finance any new initiatives.

It is important to note that, in order for this result to be meaningfully comparable to other scenarios, households should be the ultimate sector to carry the burden of the new tax. For the sake of these simulations, we will therefore also exclude natural gas and heating oil prices from the consumer basket (as diesel and petrol prices are already excluded from the socalled health index) used for the calculation of the reference index through which all wages and social benefits are automatically updated. Updating nominal wages as a result of the direct price effects of the household carbon tax would shift the burden of this tax back to firms, which will react by raising their output prices. Such a wage-price spiral would be particularly ill-advised and detrimental for competitiveness in a small open economy like Belgium[1]. It is also assumed that unions and employers cannot engage in new wage-bargaining negotiations after the introduction of a carbon tax and will thus stick to the real wage trajectory from the baseline scenario.

The tax represents *ex ante* some 0.5 % of household total consumption and the private consumption deflator increases accordingly on impact. Given that households cannot renegotiate their wages, the only way in which they can react to this real income shock is by reducing their overall consumption. This drop in aggregate demand incites firms to lower their own demand for production factors, i.e. labour and capital goods. After five years, the introduction of such a carbon tax would reduce GDP by 0.3 % from a no-carbon tax benchmark scenario, implying the destruction of about 15 000 jobs and an increase in the unemployment rate of 0.2 of a percentage point. The public debt to GDP ratio would be lower by 0.5 percentage point compared to the baseline no-tax scenario.

- Introducing a carbon tax levied in Belgium alone, on firms, without tax refunds

In a **second scenario**, we consider the case of the Belgian government raising *ex ante* € 3.75 billion through a carbon tax levied on fuel combustion by firms in the production process. Given that Noname does not use energy

1 Also, it will enhance the difference with the transmission mechanisms at play in this scenario compared to subsequent ones, where we will directly put the burden of the tax on firms or where the government directly compensates the households for the real income loss through a lump sum transfer.

as a production factor in its production function, we emulate this measure by raising the tax through a levy on firm's value added, where € 3.75 billion corresponds to 1.1 % of private value added. As in the previous scenario, the introduction of the carbon tax is supposed to be a purely Belgian measure, and once again the Belgian government will use the proceeds from the tax to speed up its debt reduction. Firms are price-makers and have the possibility of passing on the extra cost to buyers of their goods and services, i.e. to households (private consumption and housing investment), domestic firms (business investment) or firms abroad (exports). However, in a monopolistic competition environment with nominal rigidities, firms adjust their price only sluggishly to the implied surge in their marginal cost, temporarily absorbing the difference in their profit margins[1]. Firms put up their prices for all their customers and, in so doing, allocate the tax burden across households, domestic and foreign firms, through which the price rise will be broader-based than in the previous scenario. The rise in domestic prices erodes households' and firms' real income and the rise of the export deflator cuts into Belgian exporters' competitiveness. Given that the tax is levied on every unit of value added (a proxy for the amount of fossil fuel combustion linked to that product), the price increase for households will weigh on the prices in their entire consumer basket and not on their consumption of fossil fuels alone, as was the case in the previous scenario. We therefore let the automatic indexing mechanism play, which supports households' real income and entails more demand for private consumption and housing investment. This is done at the expense of firms' operating surplus, implying a further drop in corporate investment. On the nominal side, the wage indexation process leads to further price rises for all demand components. These wage indexation feedback effects also have further negative consequences for firms' competitiveness. Once the carbon tax has been introduced, producers face depressed domestic and export demand and reduce their output accordingly, together with employment and investment. The fall in all final demand categories causes a drop in import demand that is higher than that for exports, which softens the impact on GDP somewhat. All in all, compared to a no-carbon-tax baseline scenario, consumer prices will be 1.2 % higher after five years, while economic activity is expected to drop by 0.7 %, implying job losses of around 39 000 people and the unemployment rate is expected to increase by 0.7 of a percentage point. Also, after five years, the public debt to GDP ratio would be lower by 2.7 percentage points compared to the baseline.

In comparison to the first scenario, the tax shock is three times bigger and the transmission channels are somewhat more complex. Correcting for the size of the shock, the second scenario has a bigger effect on the average price in the economy, as measured by the GDP deflator, but a smaller effect on GDP. The activation of the automatic indexing mechanism in the second scenario is of course one cause. Another one is the fact that the price effects are now allocated over more demand components than private consumption alone and that the price elasticity of these demand components is somewhat lower. The fact that the Belgian economy holds up comparably better in the second scenario implies that second-round effects will be less detrimental for the government's accounts, especially for household direct taxes and social security contributions. Accordingly, the government will be able to reduce its debt comparably further than in the first scenario.

- Introducing a carbon tax, levied in Belgium alone, on households and firms, without tax refunds

In the **third scenario**, we simply add up the results for both previous scenarios, in order to get an idea of the total macroeconomic effects on the Belgian economy of introducing a € 50/tCO_2 tax initially and thereafter increasing by 4 % per year, on all the fossil fuel combustion by Belgian households and firms, in a scenario where only the Belgian government decides upon such a measure. After five years, GDP would be 1 % under and consumer prices 1.6 % above the baseline level, implying job losses of around 54 000 people and an unemployment rate increase of 1 pp. Taking into account all detrimental second round effects, the government would still be able to reduce its debt in proportion of GDP by 3.2 percentage points with respect to baseline.

1 This general feature of New Keynesian models about the progressive pass-through of the marginal cost to sales prices has been verified for the particular case of energy costs by Ganapati, Shapiro and Walker (2020) for the United States. Noteworthy, these authors find that consumers support no more than 75 percent of the burden of shocks to industrial energy prices, the rest being supported by the firms.

■ Introducing a carbon tax, levied EU-wide, on households and firms, without tax refunds

In a **fourth scenario**, we consider the case where the tax is not set in Belgium alone, but where the decision to introduce a carbon tax is taken at the European Union level, for every country under otherwise exactly the same conditions as described above. One of the reasons for studying such a scenario is to assess the difference regarding the repercussion on the competitiveness of Belgian firms compared to the previous scenarios. In the previous Belgium-alone scenarios, the European monetary authority did not react to idiosyncratic Belgian price dynamics as its weight is too small to have any impact on the European macroeconomic aggregates. In an EU-wide tax scenario, the European Central Bank will raise its short-term interest rate in order to calm the

Table 3

Simulations results of a CO_2 scenario:
€ 50 / ton CO_2 emission (growing at 4 % per year) for the Belgian economy

(in % of deviation from baseline, unless otherwise stated)

	Belgium alone tax levied on									Belgium and EU tax levied on			Belgium alone tax levied on		
	households only			firms only			firms and households			firms and households			firms and households		
	no tax refund			no tax refund			no tax refund			no tax refund			full tax refund		
	Y1	Y3	Y5	Y1	Y3	Y5	Y1	Y3	Y5	Y1	Y3	Y5	Y1	Y3	Y5
Price and cost developments															
Household cons. deflator	0.5	0.5	0.5	0.5	1.0	1.2	1.0	1.4	1.6	1.0	1.2	1.4	1.0	1.5	1.9
of which:															
Energy component	5.5	5.9	6.4	0.3	1.0	1.3	5.7	6.9	7.7	5.4	6.1	6.8	5.7	6.9	7.7
Export deflator	0.0	0.0	0.0	0.2	0.4	0.4	0.2	0.4	0.4	0.1	0.2	0.3	0.2	0.4	0.5
GDP deflator	0.3	0.2	0.2	0.5	0.9	1.1	0.8	1.2	1.4	0.8	1.1	1.3	0.8	1.2	1.5
Nom. compensation per hour	0.0	0.0	0.0	0.3	1.0	1.1	0.3	1.0	1.1	0.3	0.8	1.0	0.3	1.0	1.4
Real compensation per hour	–0.5	–0.5	–0.5	–0.2	0.0	0.0	–0.8	–0.5	–0.5	–0.7	–0.4	–0.5	–0.8	–0.5	–0.5
Economic activity															
Real GDP	–0.1	–0.3	–0.3	–0.1	–0.5	–0.7	–0.1	–0.8	–1.0	–0.3	–1.1	–1.3	–0.1	–0.3	0.1
Private consumption	–0.2	–0.6	–0.5	–0.1	–0.4	–0.4	–0.2	–0.9	–0.9	–0.2	–0.9	–0.9	–0.2	0.0	0.5
Business investment	–0.1	–0.8	–0.9	–0.2	–1.8	–2.6	–0.2	–2.6	–3.6	–0.4	–3.2	–4.1	–0.2	–1.3	0.3
Residential investment	–0.1	–0.4	–0.4	0.0	–0.3	–0.4	–0.1	–0.7	–0.8	–0.1	–0.7	–0.9	–0.1	–0.1	0.5
Exports	0.0	0.0	0.0	–0.1	–0.2	–0.3	–0.1	–0.2	–0.3	–0.5	–0.8	–0.9	–0.1	–0.2	–0.3
Imports	0.0	–0.1	–0.1	–0.1	–0.4	–0.4	–0.1	–0.5	–0.6	–0.4	–1.0	–1.1	–0.1	–0.3	–0.1
Real disposable household income	–0.5	–0.5	–0.5	–0.3	–0.1	–0.2	–0.8	–0.6	–0.7	–0.8	–0.6	–0.7	–0.8	0.5	0.7
Labor market															
Unemployment rate (in pp dev. from baseline)	0.0	0.2	0.3	0.0	0.4	0.7	0.0	0.6	1.0	0.0	0.7	1.1	0.0	0.4	0.3
Employment (in thousand)	–0.3	–9.1	–15.4	–0.9	–21.7	–38.7	–1.2	–30.8	–54.1	–2.2	–37.9	–62.9	–1.2	–23.5	–19.4
Fiscal developments															
Balance [1]	0.3	0.1	0.1	0.7	0.4	0.3	1.0	0.4	0.3	1.0	0.3	0.2	1.0	–0.4	–0.2
Debt to GDP ratio [2]	–0.5	–0.4	–0.5	–1.2	–2.1	–2.7	–1.6	–2.5	–3.2	–1.5	–2.0	–2.5	–1.6	–1.3	–1.5

Source: NBB.
1 % of baseline GDP.
2 pp deviation from baseline.

inflationary consequences of the new tax on producer and consumer prices. This monetary tightening has a direct and additional negative effect on domestic demand on the one hand and will entail an appreciation of the effective euro exchange rate on the other hand. Also, in this scenario, oil prices denominated in euro will fall as a result from both the euro appreciation vis-à-vis the dollar and reduced demand for oil stemming from depressed European domestic demand.

A priori, one may expect that the synchronous introduction of the carbon tax in all EU Member States would strongly attenuate the negative competitiveness effect for the Belgian firms, as all EU trade partners now face more or less comparable price effects of the higher tax pressure. However, the international scenario outlined above shows that the total picture will be more complex. Member States also trade outside the EU and introducing a carbon tax at EU level might solve intra-EU competition issues, but it will entail reduced competitiveness vis-à-vis the rest of the world. The expected increase in the effective exchange rate of the euro will only amplify this effect. Moreover, and most importantly, the reduction in demand that will follow the price rises will now take place in all other EU Member States and this will result in a reduced need for imports from Belgium, entailing a general reduction in Belgian exports through second-round cross-border trade effects. The EU-wide carbon tax consequences have been assessed with the NBB-2C model described in de Walque, Jeanfils, Lejeune, Rychalovska and Wouters (2017), and the outcomes in terms of exchange rate, prices and intra- and extra-EU foreign demand have been used to calibrate the simulation run with the Noname model and are displayed in table 3.

How would the introduction of a carbon tax levying 5 billion on Belgian households (25 %) and firms (75 %) in combination with the international environment outlined above affect the Belgian economy? Prices for Belgian importers will increase through price rises resulting from introducing the carbon tax in all other EU Member States, but will fall for goods and services coming from trade partners outside the EU as a result of the appreciation of the euro and the fall in oil prices. Domestic firms and households will react as in the first and second scenario, but external demand for Belgian products is further reduced, given that the carbon tax will reduce demand from all trade partners within the EU and demand from outside the EU will be depressed through the euro's appreciation. After five years, GDP would be 1.4 % under the baseline level and consumer prices 1.3 % above it, about 63 000 jobs would be lost, and the unemployment rate would increase by 1.1 percentage points. The government would be able to reduce the debt to GDP ratio by 2.5 percentage points compared to baseline.

- A carbon tax levied in Belgium alone, on households and firms, with tax refunds

We remember from the previous discussions in section 2 that the goal of a Pigouvian tax is not to improve the government's budget balance, but that it should instead encourage a change of behaviour in a desired direction. This is even more important if the tax is expected to be anti-redistributive by weighing more on low-income households whose energy expenses represent a larger share of the consumer basket. By investing the tax proceeds back intro the economy, this fact can somehow be offset, if not for reasons of fairness than at least for gaining political support for this tax instrument. Some production sectors might also need compensation for the fact that they are, by nature, more carbon-intensive, and will require more time to adapt to the low emissions target. We therefore consider a scenario where the tax proceeds are not used to improve the government budget but are instead redistributed evenly between households and firms. A lump-sum transfer[1] will unwind the regressive nature of the carbon tax for lower-income households and firms will get a rebate on the taxes due on their profits. While it can be expected that the extra money for households will largely be consumed through a positive real income effect, the effects on the economy from firms' tax rebates can be expected to be smaller. It will improve firms' disposable income and, through this liquidity channel, ease the financing of their investment, but there is no real incentive to pass on this benefit to prices and, according to the model logic, a large share of the benefit will just improve firms' financial balances.

1 As recommended by the US Economists' Statement on Carbon Dividends.

The simulation results for this scenario can best be compared with those of the third scenario above, where an identical simulation set-up was considered but without any tax refunds to either households or firms. The amount of the lump sum transfer to households (€ 2.5 billion) more than offsets the cost of the carbon tax directly levied on them (€ 1.75 billion), but they will of course also suffer indirectly when firms pass on their carbon taxes to final consumer prices. In this simulation set-up, it is assumed that the lump sum transfer and tax rebate are retroceded with a one-year delay, so the introduction of the tax depresses the economy first while the refunds stimulate it afterwards. After five years, real GDP is slightly above baseline (+0.1 %), while the consumer price deflator is 1.9 % above its baseline level. Employment needs more time to find its baseline again, and after five years, some 19 000 people will have lost their jobs[1]. The debt in proportion of GDP is reduced by 1.5 percentage point compared to baseline. This is almost entirely due to a denominator effect, as nominal GDP increases due to the rise in the GDP deflator. Clearly, the one-year discrepancy between the beginning of the tax policy and the transfers and tax rebates is responsible for the remaining job losses after five years : the sooner tax dividends are redistributed, the lower the economic costs.

■ Key messages from the simulation exercise

Using macroeconomic structural models available at the National Bank of Belgium, we have assessed on a five-year horizon the macroeconomic consequences of introducing a carbon tax in Belgium, fixed initially at € 50/tCO_2 (on top of all the existing fuels and emissions taxes) and growing at a yearly rate of 4 %. Such a tax would *ex ante* yield 1.1 % of GDP, a quarter of which would be paid by households and the rest by private firms. The main conclusion from this fiscal exercise is that, with no accompanying measures, such a tax levied at Belgian level would cost about 1 % of GDP at the end of the simulation horizon. Contrary to popular belief, things would not be better if the tax were to be levied at European Union level. Even though it reduces the problem of Belgian firms' competitive edge over their EU counterparts, it worsens EU firms' competitiveness in general with respect to the rest of the world and, more importantly, the inflationary effect of the tax reduces EU domestic aggregate demand, and consequently, EU demand for Belgian goods. Compared to a Belgium-only scenario, GDP would then drop by 1.3 % after five years. However, as shown by a simulation where the tax is set in Belgium only, redistributing the tax dividends to households and firms strongly mitigates the negative consequences for economic activity, and reverses them at the end of the considered horizon. This scenario confirms that a timely redistribution of the tax return is key and enables the energy cost increase to be fully offset, even if Belgium decides to introduce a carbon tax unilaterally. If the tax were to be set at EU level and accompanied by the same kind of redistribution policy in the other Member States, then the aggregate demand problem pointed up earlier would be neutralised, while coordination at EU level reduces *per se* the loss of competitiveness for domestic firms induced by a Belgium-alone scenario.

1 This highlights the importance of reducing the delay between the tax and the refund, especially for households. In British Columbia and in Switzerland, the transfers are paid on a quarterly basis.

Conclusion

The window of opportunity to reach the Paris Agreement targets is narrowing rapidly and huge efforts are still required worldwide for this goal to be attained. The group of countries committing to strict objectives regarding carbon neutrality is growing slowly but it still includes some of the largest emitters, such as Japan and the European Union. China shows encouraging signs, both in actions and intentions, and the election of Joe Biden as the next President of the US may certainly be considered as a good omen. Economists have come to a consensus about carbon pricing which they view as the first and more efficient policy instrument to adopt in order to fight the carbon emission problem in a decentralised way, leaving agents to adapt their behaviour optimally to the new constraint and the re-designed system of relative prices. The most important aspect to achieve this goal at minimal cost is to clearly announce the future carbon price growth path together with the emissions objective. Such a policy also has direct implications for the financial markets, rebalancing relative asset values in favour of light-carbon-emitting firms.

Carbon pricing initiatives have flourished around the world in the last thirty years, differing in scope and coverage. These field experiments have made it possible to collect economic data both at the macro and firm level, data that have been used in econometric studies. Research work surveyed in this article is unanimous about the carbon-reducing effect of the instrument, and none of them points to any important and unsurmountable social and economic costs of a carbon pricing policy. However, they all insist that it is highly advisable to agree on accompanying measures. First and foremost, when the tax weighs directly on households' shoulders, its dividends have to be redistributed in order to counter the fact that energy makes up a larger share of low-income households' consumption basket. This is not only important from the viewpoint of social fairness, but it is also essential to ensure political support. When the pricing mechanism is geared towards the production sector, it is also well advised to bring some temporary support to the firms and sectors that are the most exposed to fossil fuel prices, either directly or indirectly, as well as those exposed to foreign competition. Labour market measures are certainly also welcome to smooth the transition process of workers from carbon/energy-intensive jobs to often more skills-demanding low-carbon jobs.

A fiscal simulation exercise for Belgium confirms the findings of Hebbink *et al*. (2018) for the Netherlands, and of the abovementioned literature: redistributing the tax dividends enables the negative consequences of the tax on real activity and employment to be strongly mitigated in the short run, and later fully neutralised, notwithstanding the improvement in air quality and the contribution to reducing climate-related risks. Even though coordination of carbon tax policy at the EU level is certainly the preferred option both in terms of emissions coverage and competitiveness issues, simulations suggest that this conclusion is independent of such a cross-border synchronisation, as already proved by several single country experiments. Early starters could then benefit from a competitive advantage when other countries join the carbon pricing club: this has obviously been the Swedish bet. It is noteworthy that any enlargement of the "carbon pricing coalition" not only helps overcome the eternal free-riding and competitiveness problem, it also improves the returns to scale of low-carbon-oriented research and resolutely helps in the quest for a path out of a warm world.

However, it is important to recall that, although empirically validated, this conclusion remains limited to the first few years after the tax is introduced[1]. As time elapses and the fruits from the lower branches have been gathered, reaching the upper ones will become more and more dependent on technological progress which is costly to develop and diffuse. Furthermore, if low-carbon technologies were limited to rich advanced economies, emissions by emerging economies may totally ruin the efforts from a global viewpoint. It is therefore of the utmost importance that, together with research and development, low-carbon technologies are transferred at as low a possible cost for developing economies.

1 Though in Scandinavian countries the experiment has now been running for 30 years.

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Consumer prices in light of the COVID-19 crisis

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Introduction

The particularity of the COVID-19 pandemic is that it caused huge shocks to both demand and supply of goods and services, which could trigger, respectively, deflationary and inflationary pressures. Along with the lockdown, losses of income, deep uncertainty among the population and risk-avoidance behaviour, it has also resulted in a dramatic shift in consumption patterns. This article analyses inflation developments in Belgium during these exceptional times and is structured as follows.

Chapter 1 examines the principles which have been applied to ensure the continuity of the consumer price index. Indeed, some transactions became impossible for a certain time and the absence of price listings has posed unusual challenges.

Chapter 2 takes a closer look at the general inflation trends in 2020 (section 2.1) and then at the different categories. While energy developments have shaped headline inflation, we focus our attention on food price changes (section 2.2), since this essential component has gained importance in a strongly altered consumption pattern during the crisis.

Were inflation developments different in our three main neighbouring countries? Chapter 3 answers this question, by decomposing the inflation gap between its main components among other things. While some trends went in the same direction, the level of inflation differed, notably due to some specificities in Belgium.

We take a closer look at the changes in spending patterns during the pandemic in chapter 4. Data on debit card transactions capture these changes: section 4.1 is devoted to estimating their impact on total measured inflation. Households may differ in many respects, such as their level of income, and they may have been affected diversely by the dispersion of price changes for commonly purchased goods. This assumption is investigated in section 4.2, in which inflation rates are computed with differing weights according to income level.

Finally, in chapter 5, we look at consumers' qualitative opinions on inflation developments in the recent period. Since the emergence of the COVID-19 pandemic, perceptions and expectations seem to have been moving in opposite directions. This may reflect households' uncertainty about overall inflationary pressures, and the fact that their expenditure patterns have greatly changed.

1 The authors thank Ken Van Loon (Statbel) for his valuable comments and suggestions.

Throughout most of the article, the harmonised index of consumer prices (HICP) is used. The national consumer price index (NCPI) is used in chapter 4 only, for the purposes of the analysis. The methodological differences between both are mentioned where necessary.

The cut-off date for completing this article was 16 October 2020. In the meantime, new measures to fight the pandemic have been implemented, which are not taken into account in the article.

1. Price measurement in the COVID-19 crisis

The measures undertaken to fight the pandemic led to restrictions in the movements of people and to the closure of so-called non-essential stores and services, which had an impact on the measurement of the consumer price index (CPI). On the one hand, consumption patterns were forced to change (see chapter 4) and, on the other, the prices could not be quoted normally in order to construct the CPI, as transactions in some goods and services were made impossible.

The goal of the CPI is to measure the relative change in the price of a representative basket of goods and services from one month to the next. The prices of the detailed items are aggregated to form elementary indices. These are then aggregated to gradually higher levels using expenditure weights to get to the "headline" level. In Belgium, the expenditure weights used for the national consumer price index (NCPI) and the harmonised index of consumer prices (HICP) are based on survey data collected from a representative sample of households (the Household Budget Survey – HBS) and the spending reported in the national accounts. The weights should reflect the annual expenditure of an average household on each item included in the basket.

One of the key foundations of the CPI is that it anchors itself to representativity and normality (Reinsdorf *et al.*, 2020). In the same way that the CPI is built for an average household, it is also designed to measure price change during normal economic conditions. Every year, the weight of the CPI components is based on the estimated average consumption expenditure of the previous year. These weights are kept constant throughout the year, that is, monthly fluctuations in the consumption patterns are never taken into account (Statbel, 2020). Under normal circumstances, certain months are marked by very low or inexistent consumption of some goods or services (for instance, amusement parks during the winter months).

In the context of the COVID-19 pandemic and the ensuing price measurement problems (mainly for the months of April and May 2020)[1], Eurostat (2020) has drawn up guidelines[2] in consultation with the national statistical institutes (Statbel in Belgium), to guarantee comparability. The general principles – for the HICP and the NCPI – can be summarised as follows: the weights of the published indices should remain stable; indices for all product groups should continue to be published; the number of imputed (estimated) prices should be kept to a minimum, meaning that, whenever possible, missing price observations should be replaced by price quotes obtained from other sources (e.g. outlets' websites, telephone and e-mail enquiries).

First of all, due to the lockdown that began on 18 March 2020, field price collection by pollsters in outlets became problematic (both due to shutting down of the non-essential stores, and the health-precautionary measures of pollsters). However, the need for local price collection has been greatly reduced in Belgium since the switch to big data (scanner data, web scraping, administrative data). Since 2014, the share of field price collection has fallen from about 64 % of the basket weight to about 32 % in 2020. In addition, local price collectors follow prices that do not systematically change every month (typically, restaurants and cafés, hairdressers, etc.). For the above reasons, it has been decided to temporarily suspend the field price collection. For shops that were

1 The prices for the March index had already been mostly quoted when the lockdown started.
2 https://ec.europa.eu/eurostat/documents/10186/10693286/HICP_guidance.pdf.

still open and where "digital" prices could not be used (mainly bakers and butchers), prices were collected by telephone or online by Statbel.

For products whose consumption could no longer take place in physical outlets, but still online (e.g. clothes, toys, electronic goods, etc.), prices were collected online, in an attempt to keep the number of missing prices to a minimum.

As regards goods and services that could no longer be bought, prices could not be observed. If no seasonal pattern is usually observed in the monthly pricing (e.g. restaurants, hairdressers, electricians, etc.), the last available prices were carried forward. This imputation was considered as appropriate since these prices are fairly stable from month to month[1].

When monthly price changes are characterised by a seasonal pattern (e.g. hotels, travel, flowers, etc.), prices could not be simply rolled over, because this would cause a break in the index series and thus bias the year-on-year inflation rate. Imputed prices have been obtained by applying the same monthly price change of the previous year.

In April, price imputations were necessary for 24 % of the consumption basket. In May, this was the case for 17 %, while in June, only 4 % of prices were imputed.

Table 1

Price collection and imputation rules during the lockdown

	Method	Example
Transactions possible		
Physical outlets open	Scanner data, web, telephone	Food, pharmacy
Physical outlets closed	Web	Clothes, electronics, toys
Transactions impossible		
No seasonal pattern	Carry forward	Purchase of cars, jewelery, restaurants, hairdressers
Seasonal pattern	Carry forward based on previous year	Hotels, travel, airline tickets

Source: Statbel.

2. Inflation developments in Belgium

2.1 Main developments

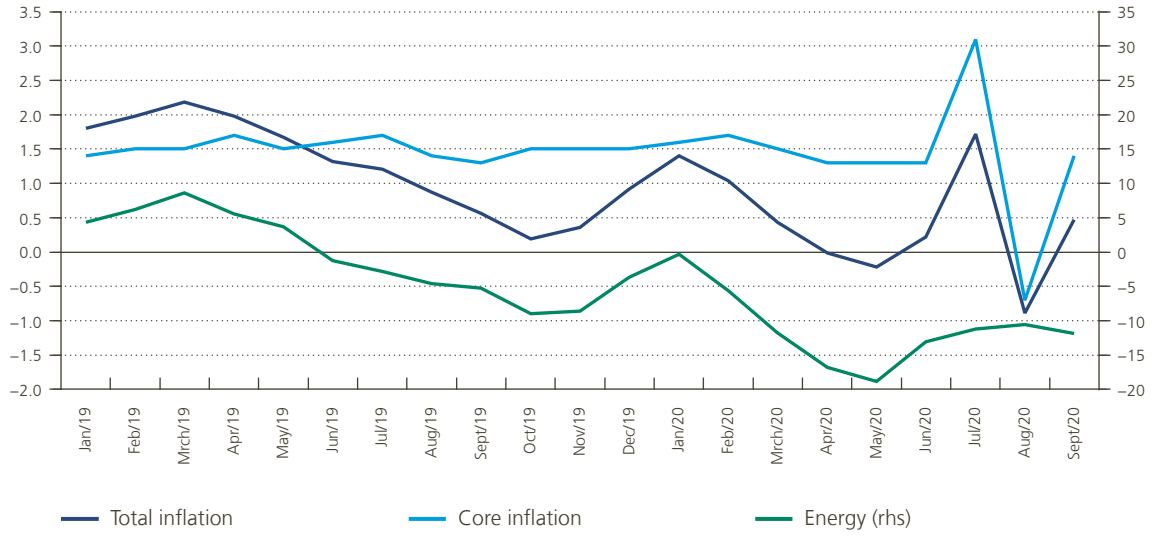
Just as in 2019, Belgian total inflation movements were mainly driven by energy price developments in 2020. This can mainly be traced back to declining Brent oil prices, which caused inflation from motor fuels and liquid fuels to drop sharply. At the same time, gas prices in 2019 and 2020 were also significantly below their level the year before, reflecting a more ample global supply. Along with the outbreak of the COVID-19 crisis, oil prices collapsed in March and April 2020, causing total inflation to fall into negative territory in May. In comparison, core inflation – which excludes the volatile components and aggregates of non-energy industrial goods and

1 According to Statbel, this method is also used in normal times, for instance at the end of the football season, prices are rolled over until the start of the new season.

Chart 1

Main inflation developments in Belgium

(year-on-year changes in the HICP, in %)



Source: Eurostat.

services – remained flat throughout 2019 and the first half of 2020. Only when the summer sales were postponed from July to August did yearly core inflation jump and crash in the corresponding months.

The broad picture hides some specificities among the other sub-components of the price index in 2020, namely unprocessed and processed food.

2.2 Food price developments

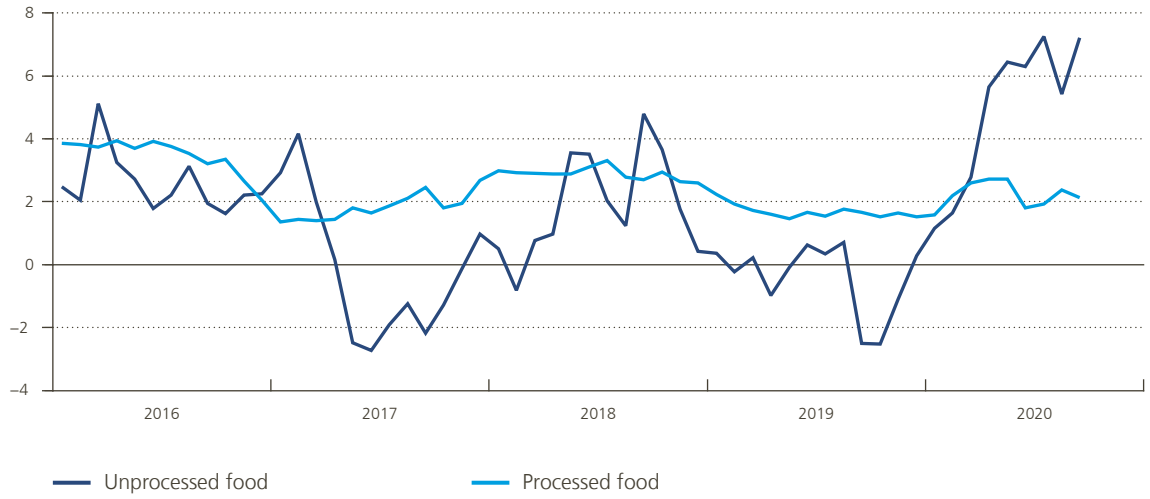
Since the end of 2019, food inflation has started to accelerate; a process that continued during the Spring lockdown and the following months. This movement can be explained by both COVID and non-COVID related factors. As regards the first, it was caused by the higher costs for health precautionary measures (such as the required distance between workers), the high rate of illness amongst workers that had to be replaced by more expensive interim workers, more difficult transportation due to, for instance, cancelled flights of food products from foreign countries, or (road) cargo trade of goods coming from countries severely affected by the crisis, etc. In addition, in order to discourage hoarding behaviour, the government decided to impose a ban on special offers in supermarkets, starting on 18 March. This decision was partially reversed from 3 April onwards, by allowing promotions that were decided before 18 March. Finally, new offers were allowed again from 4 May onwards. The special offer ban mostly had an upward impact on the inflation rate for April, although it continued to affect prices in May: once supermarkets were allowed to have promotions again, it took some time to adapt their flyers and other merchandise. Non-COVID-related factors include the particularly low food price growth in 2019 and – regarding unprocessed food – high pork prices due to swine fever[1], meteorological factors that mostly affected fruit prices in early 2020, etc.

1 The African swine fever started in 2019. The result of it was higher demand by notably China for European pork, which pushed up prices considerably.

Chart 2

Inflation rate of food in Belgium

(year-on-year change in the HICP, in %)



Source: Eurostat.

Since unprocessed food prices are more volatile than processed food in general, the former has again shown larger inflation swings: downwards in 2019; and upwards in 2020. Besides high pork prices, some specific goods have shown particularly sharply rising inflation rates. For instance, as Spain has been hit hard by the coronavirus crisis, citrus fruit has shown very high inflation rates. Due to workers' illness, the fruit could not be harvested, and transport to other countries has been more difficult. Shrimps that are often peeled in Morocco could not easily be transported to and from that country either and illness among workers also disrupted the peeling itself.

3. Situation in Belgium compared to the neighbouring countries

Comparing Belgian inflation rates with those in its three main neighbouring countries (Germany, France, the Netherlands) reveals a common trend in the first few months of 2020, namely a falling inflation rate between February and April, as the coronavirus crisis led to a sharp fall in the price of oil. Inflation in the three main neighbouring countries and in the euro area rose marginally in June as the strongly negative impact of the year-on-year fall in oil prices started tapering out. However, this oil price decline during the crisis hides opposite trend in food prices; food inflation increased in the course of 2020, particularly for unprocessed food which was as much as 10 % in April in the three neighbouring countries on average. According to the EC (2020), all over the EU, this category of goods has been affected by supply chain disruptions, shortages of seasonal workers in the agriculture sector and also by demand substitution.

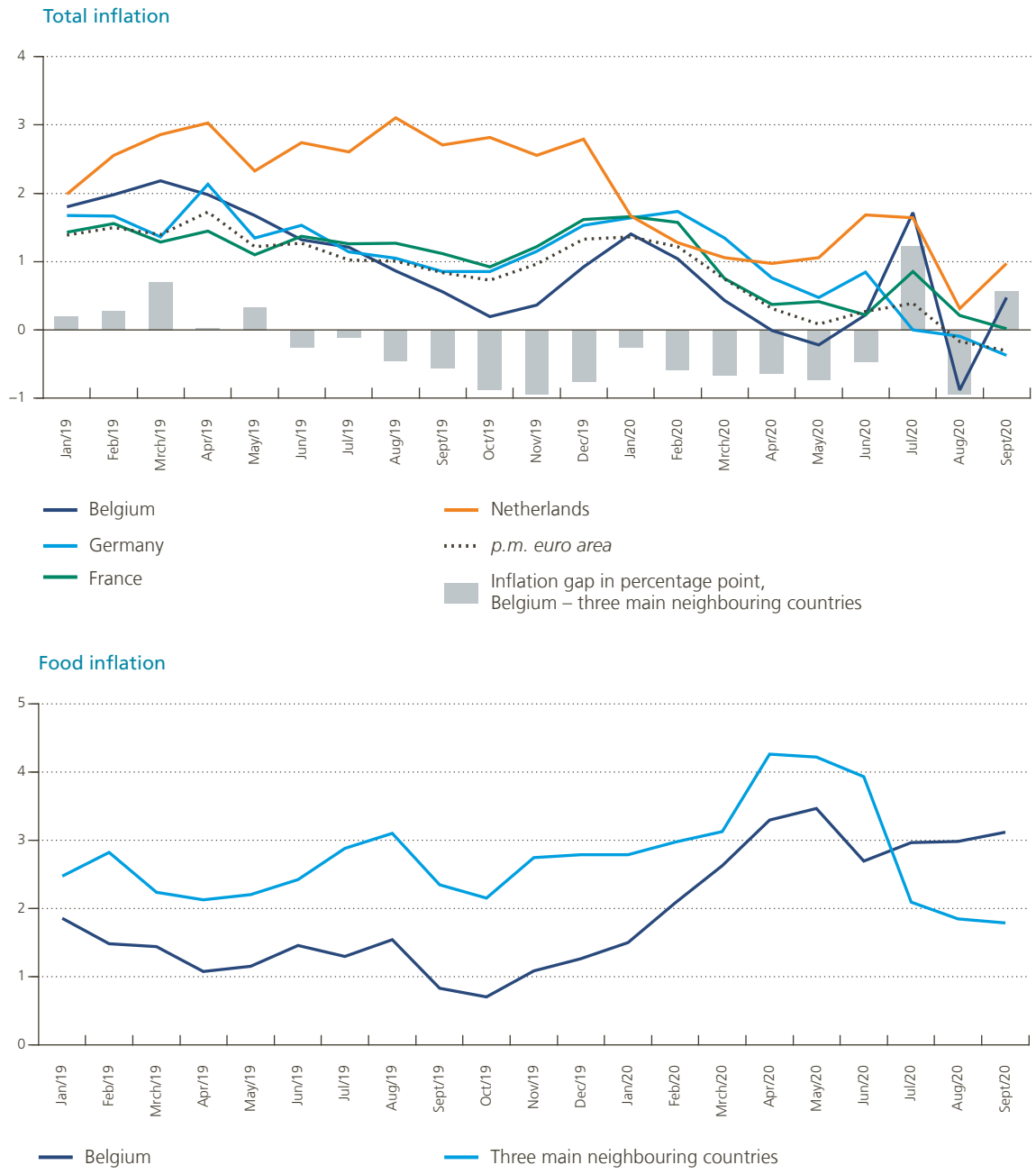
In the context of the post-lockdown period, some countries decided to postpone the summer sales[1]. Such was the case in Belgium, France and Italy, for example. This explains the year-on-year pick-up of inflation in July in the

1 In some countries, the period of sales has also been shortened or prolonged.

Chart 3

Inflation rate in Belgium and its three main neighbouring countries

(year-on-year changes of the HICP, in %, unless otherwise stated)



Source: Eurostat.

countries concerned followed by a drop in August[1]. Nonetheless, the falling inflation in July on average in the three main neighbouring countries is caused by the economy-wide temporary cut of VAT rates from 1 July to 31 December in Germany (regular rate cut from 19 % to 16 % and reduced rate cut from 7 % to 5 %). While the pass-through to consumer prices is visible in some sectors in Germany (almost full for food), the VAT rate cut decided in Belgium

1 In the HICP, sales are processed in the month where they take place. Hence, with this postponement, a trough (July 2019) is compared to a normal level (July 2020) and a normal level (August 2019) is compared to a trough (August 2020). While the Netherlands did not postpone the seasonal sales period, both NEIG inflation and services inflation have dropped, mainly due to respectively cheaper clothing compared to one year before and a fall in the prices of plane tickets and package holidays year on year.

from 8 June to 31 December for the catering sector did not exert any visible impact on the consumer prices in restaurants and cafés (this was not the aim of the measure, rather giving financial breathing room for the sector).

While the inflation gap between Belgium and its three main neighbouring countries has been "in favour" of Belgium throughout the first half of 2020, as a result of the sales being postponed, the gap jumped in July, to 1.2 percentage points, and dropped in August to –0.9 of a percentage point. In September, the Belgian rate returned to a more "normal" level, but the gap moved into positive territory (0.6 of a percentage point), due to the negative rate in Germany. While the role of the sales being postponed is clear from chart 3, looking more closely at the breakdown of the gap, some other specific developments appear.

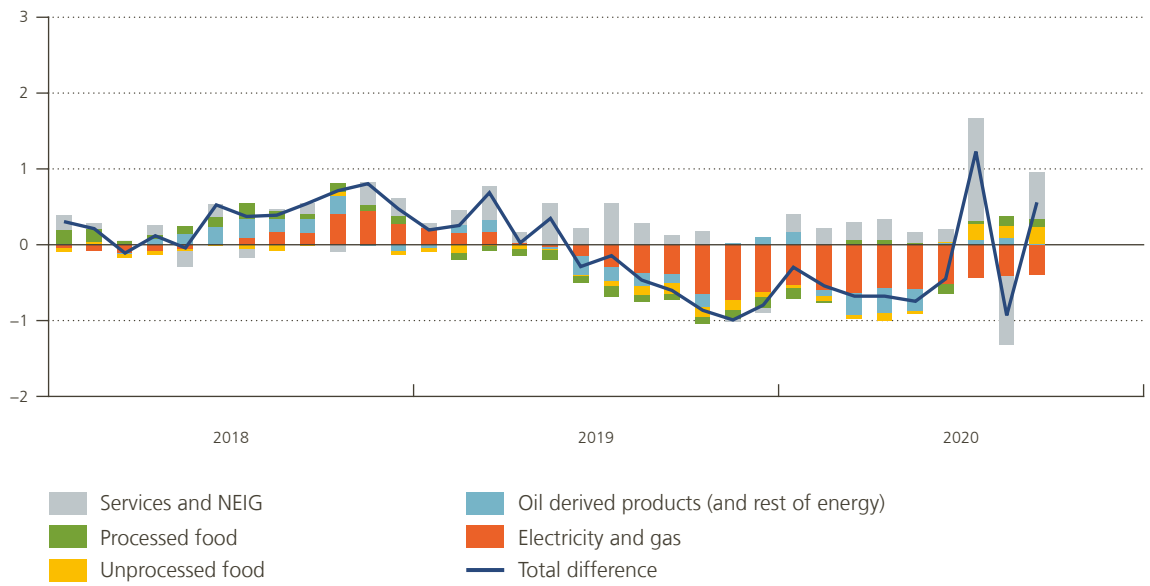
In terms of energy products, gas and electricity made the biggest contribution to reducing the inflation gap between Belgium and its neighbours, with gas prices coming down much more significantly in Belgium. Network charges and non-VAT levies affecting gas prices are quite a bit lower in Belgium, meaning that lower wholesale prices (in the context of more abundant global supply) have a much more significant impact on consumer end prices. In addition, gas contracts are more often variable (with intermediate price changes) in Belgium than in the neighbouring countries (Observatoire des prix, 2020). Finally, Belgian supplies of gas have more diverse origins, as the gas is brought in through the port of Zeebrugge.

Several events have put downward pressure on electricity prices in Belgium since 2019 (gas developments, increased capacity of power plants and more recently, the fall in demand for electricity due to the pandemic). Changes in electricity prices in the HICP depend on the structure of the final price (network tariffs, VAT rates, energy component), several factors related to supply and domestic production, factors related to demand (economic activity, weather, etc.), the functioning of the market (different switch rates), the types of contracts offered to customers. In this respect, Belgium has shown stronger variations compared to the neighbouring countries, which could be explained by a bigger share of variable contracts (30 %), with a tighter link to the underlying prices of other commodities (Observatoire des prix, 2020). Despite the fall in economic activity,

Chart 4

Breakdown of the inflation gap between Belgium and its three main neighbouring countries

(in percentage points)



Source: Eurostat.

electricity prices rose slightly year-on-year in Germany during the first half of the year, while electricity inflation remained high in France, notably due to the rise in regulated power prices in June 2019, followed by an increase in the tax on final electricity consumption in February 2020. On the contrary, electricity prices have fallen dramatically in the Netherlands because of lower taxation since January 2020.

4. Changing expenditure patterns

4.1 Temporary loss of representativeness

Households' consumption pattern changed drastically as a result of the pandemic, particularly in March and April, and to a lesser extent in the following months. For instance, most cultural activities were cancelled, restaurants and bars had to remain closed between 14 March and 8 June, the closing of non-essential shops (e.g. clothes) was more gradual in March, as well as their re-opening in May. So, consumers were effectively forced to save, and, in relative terms, spent a much larger part of their budget on food.

In the CPI, weightings are updated once a year (with the publication of the January index). Given the particular situation, they were clearly not representative for a couple of months in 2020. This difference in the allocation of spending during the Spring lockdown may have fuelled the perception of higher inflation than that reported by the traditional index (see chapter 5). That is why we have constructed a consumer price index based on the HICP principles, but with weightings more in line with actual consumption. For this, we used a sample of debit card data, giving the total amopunt of monthly transactions per category of shops. Note that it has some limits. First, the data come from only one payment and transaction services company, so the results might be disrupted by particularities and specific characteristics of that company (over- or under-representation of some sectors and under-coverage of certain demographics, as some segments of the population tend to use cash instead of cards). Second, there is a lack of granularity in the data; the database distinguishes a limited amount of different shop types[1], whereas the COICOP categories[2] of the HICP are much more detailed. Obviously, the shop types do not correspond perfectly to the COICOP categories, so some assumptions have had to be made in order to reclassify all the COICOP categories (usually at 5-digit level) into the categories of shops. Third, due to the monthly update of the weightings, there is seasonality[3] in the spending patterns. There was a sizeable increase of spending in hotels in July 2020 compared to the previous month, which is a yearly phenomenon related to the summer holidays. Lastly, in the official CPI, prices are captured for the month in which the good or service is consumed, even though the transaction might have been earlier. For instance, prices of plane tickets that were booked in January but used in August will appear in the month of August's CPI. By contrast, the debit card data only show the expenditure at the moment of the transaction itself (in the example here, this would be in January). It is worth noting that these limitations with the data not only call for caution in interpreting the results, but also make the data unsuitable for official statistics.

Despite those limits, it is worth looking at a consumer price index with monthly changing weights, in order to gauge the effect of the drastic change in consumption patterns on the inflation level. The weights of 2019

1 There are 17 shop types distinguished. They can be described as: restaurants, hotels, travel agencies & bungalow parks, airlines, fuels, food, vehicles, home interior, electro, clothing, medical, leisure & education, telecoms & electricity & gas, transport, construction, beauty, and others.

2 COICOP refers to Classification of Individual Consumption by Purpose. It classifies the individual consumption expenditure of households into different categories, and it is used in the consumer price indices. 2-digit level categories are aggregates of higher-level categories. For instance, the category "food and beverages" is represented by the 2-digit level category COICOP 01. Into food and beverages, we observe for instance the 5-digit level category COICOP 01.1.1.1 "rice", that is part of the 4-digit level category COICOP 01.1.1 "bread and cereals", on its turn part of COICOP 01.1 "food". There are about 235 COICOP categories at the 5-digit level.

3 In the official consumer price index, this problem is not present in the weights, since they are only updated on an annual basis. However, seasonality is found in the price data (higher prices in the summer for this category).

and January 2020 are the weights from the official HICP. From February 2020 onwards; weights are calculated based on changes in the sample of debit card expenditure data per shop category with respect to January 2020.

According to this sample of debit card data, the relative weights of most of the non-food sub-categories – such as clothing, restaurants and bars, etc. – showed a V-shape. This means that they declined from February onwards to reach a low point in April 2020, after which they went up again. It must be stressed that these weights are relative to total spending. In absolute terms, total spending in April was down considerably on January 2020. To some extent, consumers were forced to save – except for their primary necessities such as food – as some goods and services were simply not available or people preferred to stay at home for health reasons. The relative weight of the food category shot up in April, i.e. during the peak of the restrictions. Still, it is interesting to note that, in absolute terms, food spending did not reach a peak in April: month-on-month spending actually went up gradually.

Today's HICP index is a Laspeyres-type index, with chain-linking to December of the previous year's prices. A Laspeyres index assumes that quantities (i.e. representative basket) are those of the price reference period[1]. However, in our framework, we want to construct an index with weights that represent the current situation. A Paasche-type index enables us to let the weights vary on a monthly basis. The respective formulae for these indices are the following:

Paasche index:

$$\Delta P = \frac{\sum p_{m,i} \cdot q_{m,i}}{\sum p_{t_0,i} \cdot q_{m,i}} \cdot 100$$

Laspeyres index:

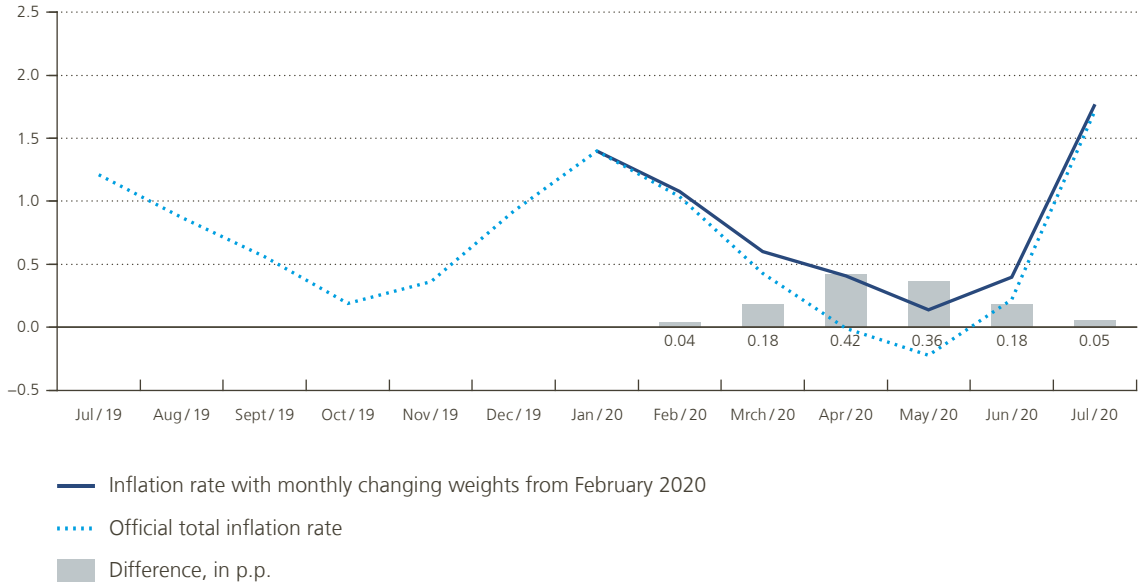
$$\Delta P = \frac{\sum p_{m,i} \cdot q_{t_0,i}}{\sum p_{t_0,i} \cdot q_{t_0,i}} \cdot 100$$

1 Expenditures of the previous year are updated to prices of December of that year.

Chart 5

Estimated inflation rate on the basis of monthly changing weights, against official HICP inflation rate

(year-on-year changes in the index, in %, unless otherwise stated)



Source: Eurostat, sample of debit card data, own calculations.

Where m refers to the current month, t_0 refers to the base period, and i represents the different shop types.

Still, in order to better capture the change in consumer spending from one period to the other, a Fisher index is recommended instead: it is calculated as a geometric mean of the Laspeyres index and the Paasche index, so it uses both the base period basket and the current period basket. The Fisher index is a so-called "superlative" index, that makes equal use of prices and quantities in both periods being compared (the reference period and the current period) (IMF, 2004). Therefore, we choose a Fisher index with monthly changing weights. December 2019 is used as the base period, as for the official Laspeyres-type HICP index.

When using the official HICP weights for 2019 and January 2020, and the estimated weights from February 2020, we obtain a higher inflation rate than the official one, especially in April 2020, with a difference of 0.4 of a percentage point in that month. This is not surprising, given the rise in food prices (see above) and the bigger weight of that category in total spending. As of May, the differences between the two indices became smaller, as the relative weights of the different sub-categories returned to a more normal situation. Over the months from February to July, the average year-on-year inflation rate according to the official HICP came to 0.5 %, whereas we estimate it to be 0.7 % with monthly changing weights. So, the average difference between the two series amounts to 0.2 of a percentage point.

Finally, when interpreting these results, it is worthwhile noting that differences with respect to the official HICP are not purely the result of the COVID crisis: an alternatively calculated index with monthly changing weights would have been different than the official HICP as well if there had been no COVID crisis at all.

4.2 Inflation differences according to household type

The previous sections have shown how the pandemic has brought unique changes in the consumption patterns of the population, along with marked changes in the prices of some components. While the consumer price index is constructed for an average Belgian household, households may differ in many respects, such as their level of income. For instance, a family with less revenue spends a relatively bigger part of their income on fixed costs such as housing rent. So, price movements of goods and services influence the groups differently, depending on their relative weights in each household's consumption pattern.

The household budget survey (HBS) distinguishes spending across different income categories, per quartile[1]. Even though the sample becomes smaller on a more detailed level (i.e. the individual product items level), it still enables a consumer price index on an aggregate level to be constructed, with weights that vary across different household types[2]. The HBS is the primary source for determining the weightings for the national consumer price index (NCPI), so this chapter will refer to the NCPI, and not the HICP like the rest of the article.

It might be surprising that those who spend the largest proportion of their income on food are not the lowest income families, but the highest income families (see table in the Annex). This could be due to the fact that high-income families are probably more inclined to buy branded products and higher-quality, thus more expensive, food. By contrast, the share of electricity, gas and heating oil is the largest for the lowest income categories.

However, the pandemic has forced all consumers to have a rather similar consumer basket; differences in spending patterns across households have been narrowing. Because some goods and services were not available

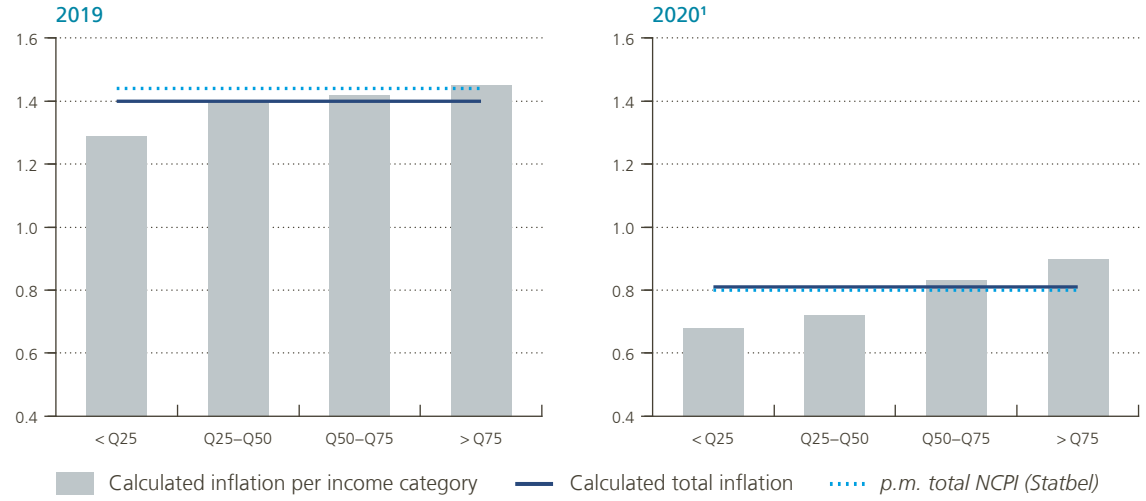
1 The income quartiles divide the population of households into four equal groups depending on their income. Each group represents 25 % of the income categories, from the lowest quartile up to the highest quartile (HBS, 2018).

2 Note that the weights vary according to different household types, but the price indices that are used are still the aggregate ones. This is a caveat, since low-income households also buy different types of products for certain categories than high-income families (cars, for instance). In order to reflect this, ideally, different price indices per income category should be used (but these do not exist).

Chart 6

Inflation rates: total and according to income category

(year-on-year changes of the NCPI, in %)



Sources: Statbel, own calculations.

1 Data from January to September.

during the Spring lockdown, everyone was forced to spend relatively more on – mostly – food. As a result, the consumer basket of the lowest incomes may have become closer to that of the highest incomes.

On the basis of the latest HBS, i.e. the 2018 survey[1], we have calculated total NCPI inflation in a simplified way[2], as well as inflation per income quartile. Chart 6 shows the inflation rate, according to household type, that would be achieved if the consumption patterns from the HBS reflected the actual situation. In light of the COVID-19 crisis, oil prices fell sharply in early 2020. At the lowest point, energy inflation according to the NCPI came to –13.8 % in May. The share of electricity, gas and heating oil (three categories that have registered declining inflation rates since the beginning of 2019) being the largest for the lowest income categories, and the share of food (with higher inflation rates in 2020) being the largest for higher-income families, the lowest quartile has achieved somewhat lower total inflation rates in 2020 (0.7 % on average during the first nine months of 2020) than the highest quartile (0.9 %).

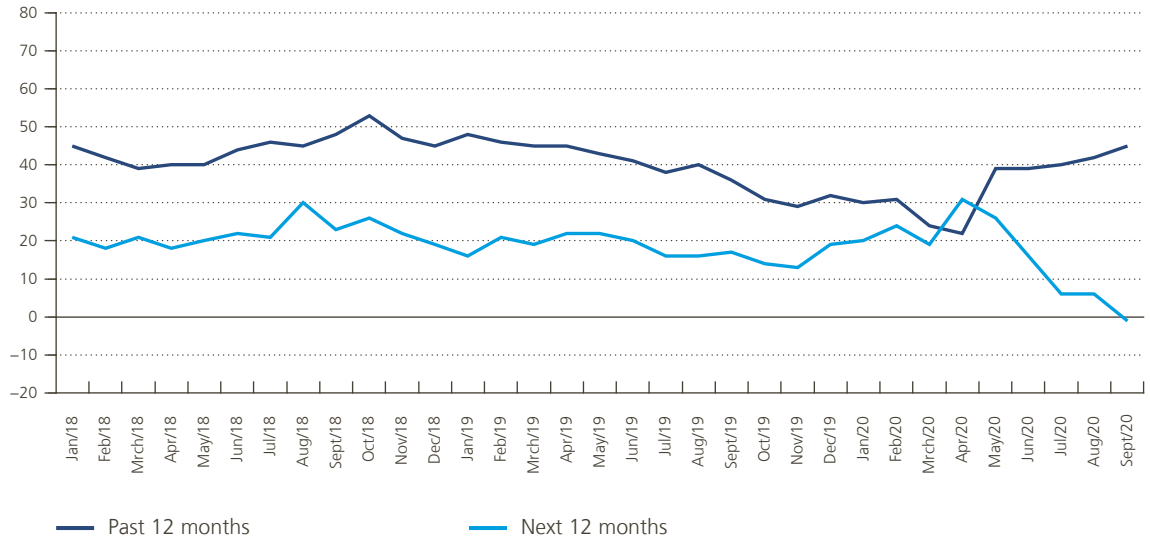
1 The HBS is conducted every two years.

2 That is, we only took out the categories "imputed rents", "drugs", "life insurance", "hospitalisation insurance" and "health insurance" from the HBS as they are not taken into account in the CPI. However, Statbel applies more corrections than we did and takes weights from the national accounts for some categories. As a result, we have a larger weight for category 12 "personal care and services" (mostly due to insurances) than the actual published weights in the NCPI. Also, we take the weights from the 2018 HBS for the calculation of the indices for 2018, 2019 and 2020, applying a so-called price update for the latter two years. Since the 2018 HBS was only available at the end of 2019, Statbel only takes the weights of the 2018 HBS from the year 2020 onwards; the 2018 and 2019 weights are in fact based on the 2016 HBS (with a price update). In the same way as we re-calculated total inflation, we calculated inflation per income quartile, by adapting the weights accordingly. Our calculated total inflation approaches the official publication very closely, so we can assume that our calculation per income quartile is reliable.

Chart 7

Perceived and expected trends in prices

(balance statistic)



Source: NBB (consumer surveys).

5. Consumer surveys

Consumers' qualitative and quantitative opinions on inflation developments are polled regularly by the NBB as part of the Joint Harmonised EU Programme of Business and Consumer Surveys. The surveys are designed to be representative at national level. Every month, around 2 000 randomly selected consumers are asked two questions about price developments. The first question refers to consumers' perceptions of past price developments ("How do you think that consumer prices have developed over the last 12 months?")[1]. The second question polls their expectations about future price developments ("By comparison with the past 12 months, how do you expect that consumer prices will develop over the next 12 months?")[2]. An aggregate measure of consumers' opinions – the "balance statistic" – is calculated as the difference between the relative frequencies of responses falling in different categories[3].

We present the results of the qualitative questions. So, the series only provide information on the directional change in prices over the past and next 12 months, but with no explicit indication of the magnitude of the perceived and expected rate of inflation.

As regards inflation perceptions (past 12 months), the turnaround observed in May 2020 put a stop to the downward trend which had been observed from the end of 2018 to April 2020. Inflation perceptions remained stable up to August and a slight rise was observed, in September. While inflation expectations (next 12 months)

1 As regards qualitative assessments, possible answers include: They have: 1. risen a lot; 2. risen moderately; 3. risen slightly; 4. stayed about the same; 5. fallen; 6. don't know.

2 They will: 1. increase more rapidly; 2. increase at the same rate; 3. increase at a slower rate; 4. stay about the same; 5. fall; 6. don't know.

3 Answers are weighted using a scheme that attributes different weights according to the answers (for example, the middle response and the "don't know" response are attributed zero weights). For more details on the way the surveys are conducted and the methodology, see: https://www.nbb.be/doc/dq/e_method/m_survey_consumer_en.pdf

had remained fairly stable since the end of 2016, they shot up in April 2020 (i.e. the balance statistic recorded the largest monthly increase for years) at the height of the lockdown, probably reflecting the economic stress situation. Thereafter, the trend reversed and the indicator has fallen regularly. A regular fall in the expectations indicator has been observed in other European countries as well.

Clearly, during this confusing period, perceptions and expectations moved in opposite directions. This was also the case in other countries such as France. The fact that certain goods and services had disappeared from the

BOX 1

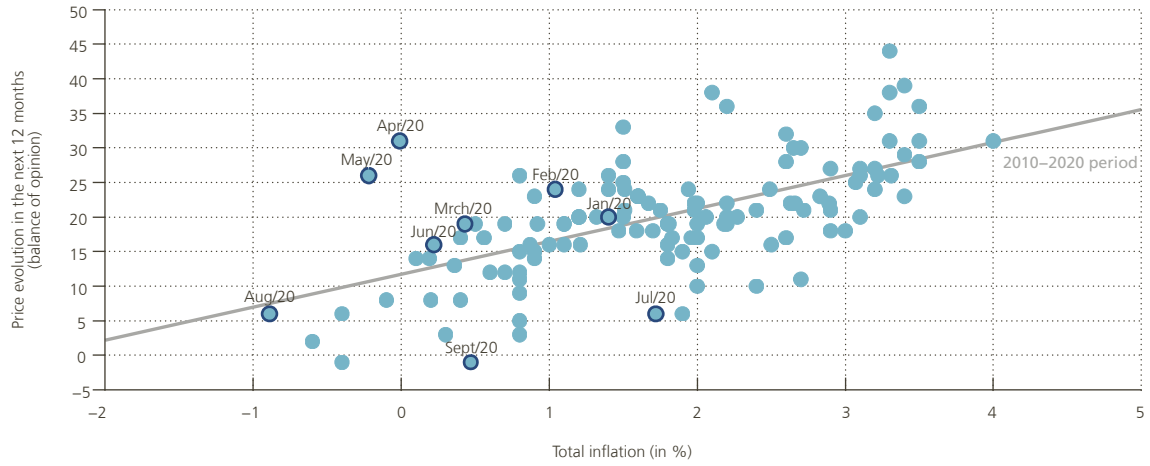
Reports by the media

After the first couple of weeks of the lockdown, the media reported high price rises in supermarkets, notably based on a daily updated information chart by the consumer organisation Test Aankoop/Test Achats (see Annex). In that chart, average prices of a fixed basket of products in various large supermarket chains are shown. On this basis, at the end of March, the media highlighted price increases of 5 to 7 % in some supermarkets, compared to the beginning of March. This gave the impression that the price increases reported in the official consumer price index were smaller than those reported by the consumer organisation.

However, the findings of the latter and the following reports in the media should be nuanced. Firstly, Test Aankoop/Test Achats shows price growth rates compared with the beginning of March. So, it cannot be ruled out that the selected prices were exceptionally low at the start of March in those supermarkets where the highest increases were observed. Second, the price increases of 5 to 7 % at the end of March that were highlighted by the media are in the supermarkets whose prices rose the most. At the same time, some retailers left their prices unchanged from the beginning of March ; or even saw their prices decline slightly. Third, the consumer organisation presents price growth figures on a daily basis, so it shows fluctuations. The consumer price indices by Statbel, by contrast, take an average of prices for about the first two weeks of the month in the case of the NCPI and about the first three weeks for the HICP. Fourth, the basket that is followed by Test Aankoop/Test Achats consists of products sold only in supermarkets, therefore a large part of it consists of food products. The Statbel price indices are not contradictory as they also report high price increases for food, both due to COVID-related and non-COVID-related factors.

Chart 8

Observed inflation and inflation expectations in Belgium [1]



Sources: Eurostat, NBB.
1 Chart based on Gautier *et al.* (2020).

usual consumer basket may have increased households' uncertainty about overall inflationary pressures, as it greatly transformed their expenditure patterns and made it difficult – possibly even impossible – to observe prices (Gautier *et al.*, 2020). In Belgium, the temporary ban on special offers may have played a role in the perception of the price growth and the role of the media in the assessment of inflationary or deflationary pressures should not be neglected. Regarding perceptions, the media reported high price rises in supermarkets during the Spring lockdown. This issue is developed in the following box.

Households' expectations are generally well correlated with actual inflation. Yet, at the time of the March-April lockdown, households' inflation expectations and measured inflation diverged. This was also the case in other European countries (Gautier *et al.*, 2020). While total inflation fell sharply from January 2020 to May 2020 in Belgium, households expected a sharp increase in prices when surveyed in April (see chart 8).

The gap that appeared between households' actual consumption structure during the COVID-19 pandemic and that of the reference basket used for the price index could help understand the divergence between observed inflation (low) and household expectations (rising in April). Indeed, the less frequently consumed goods are those for which prices rose the least rapidly (such as some services) or even fell (fuels), while the more often consumed goods are those for which prices grew the most (food). In April, the higher proportion of households expecting a strong price rise could be explained by an overreaction to changes in food prices. That is, the prices of recently purchased goods tend to be overweighted in inflation expectations (Gautier *et al.*, 2020) and several studies have shown that, when forming inflation expectations, households weigh food prices much higher than the actual share of food in expenditure (Peersman, 2018). Regarding the energy component, most households pay a fixed advance for their consumption of gas and electricity at home and are not immediately aware of falling prices. However, as underlined above, the expectations are on a declining path.

Conclusion

The COVID-19 pandemic has challenged the measurement of prices in several ways. Transactions for travel and transport, restaurants, personal care services, cultural and sports events, some manufactured goods, etc. became impossible at the peak of the crisis and their prices had to be estimated. This required coordination and harmonisation efforts at EU level. The growing use of big data in Belgium – namely scanner data from supermarkets, web-scraping for clothing shops – helped overcome the health measures which made price quoting in shops more difficult or impossible. The "digitalisation" of the price index construction has proved particularly useful in this respect.

In the first few months of 2020, total inflation was largely shaped by energy developments. The impact of the COVID-19 pandemic pushed oil prices down. Other energy products have been affected as well. Food inflation accelerated considerably, both due to COVID-19 and other factors not related to the pandemic. This movement has been observed in our main neighbouring countries as well. The negative gap between Belgium and the latter during the first half of the year finds its origin mainly in energy price developments, indirectly linked to the pandemic.

The expenditure patterns were forced to change as a result of the confinement and risk-avoidance behaviour, notably. Some have argued that the CPI weights should be updated in order to reflect this dramatic shift in household expenditure patterns on consumer prices. While we do not question the current methodology of the HICP or NCPI, we have attempted to estimate the impact this would have on total inflation, based on a sample of debit card transaction data. As expected, inflation would have been higher; i.e. by on average 0.2 of a percentage point over the February–July period. Data on credit and debit card transactions have been used in several other countries to conduct the same type of exercise for economic analysis purposes. Wider availability of such data (while ensuring anonymity) would prove promising in times of rapidly changing economic conditions because of its timeliness and high frequency.

Households may have been affected diversely by the dispersion of price changes for commonly purchased goods. We have calculated inflation rates according to different household types defined by their level of income, with a weighting scheme that represents their spending pattern. Lower-income households have experienced lower inflation rates in the most recent period. However, this finding is based on the weights according to the 2018 HBS, which does not necessarily represent the actual situation of the pandemic.

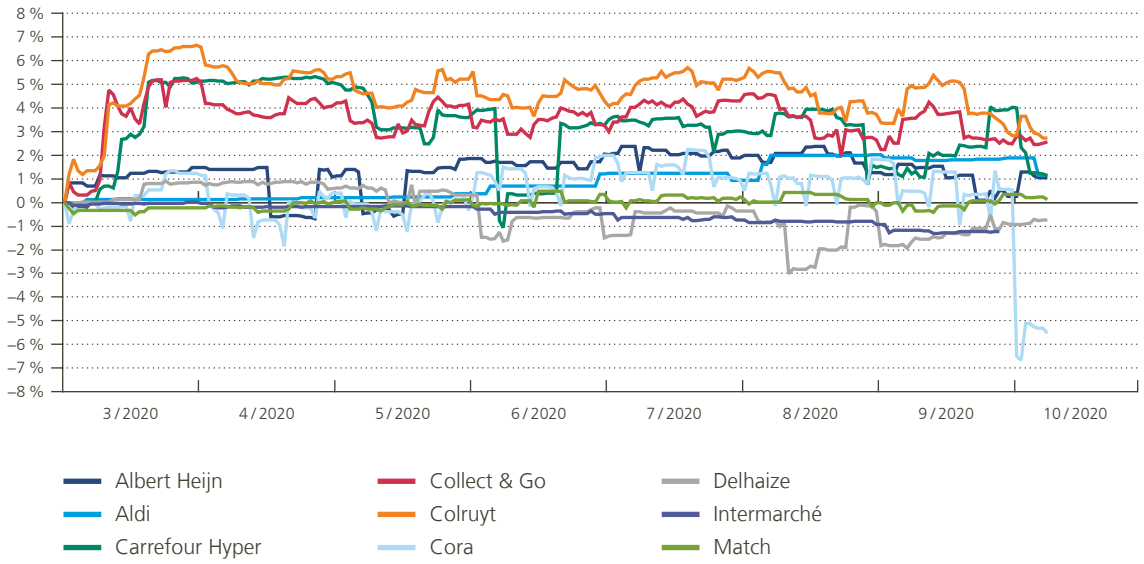
The challenge of measuring prices and inflation in times of COVID-19 is also reflected in consumer surveys, where perceptions and expectations seem to be temporarily disconnected. Comparing inflation expectations and observed inflation, while the latter was falling for several months in a row, expectations picked up strongly in April 2020. The influence of the everyday consumer basket may have played a role here. The media's role in forming inflation perceptions should not be neglected either.

With the pandemic not behind us yet, the issues raised in this article remain relevant and open the way to the use of alternative sources of data or surveys and further analyses in this respect.

Annexes

Daily updated chart published by Test Aankoop/Test Achats on 12 October

(daily price growth rates per supermarket with respect to the reference period, i.e. the beginning of March)



Source: Test Aankoop/Test Achats.

Consumer basket weights

(official versus calculated, for the total index and per income quartile, unless otherwise stated)

		Official total NCPI 2020	Total HBS	< Q25	Q25-Q50	Q50-Q75	> Q75
CP01	Food and non-alcoholic beverages	*176*	**172**	168	174	166	177
CP02	Alcoholic beverages, tobacco	*25*	**25**	34	28	25	19
CP03	Clothing and shoes	*59*	**57**	39	49	57	69
CP04	Living costs, water, electricity, gas and other fuels	*176*	**161**	277	200	154	98
	of which:						
	Electricity	*32*	**29**	38	33	30	24
	Gas	*15*	**15**	21	17	13	13
	Heating oil	*12*	**10**	14	12	10	8
CP05	Furniture, household appliances and maintenance products	*60*	**64**	41	51	68	79
CP06	Health	*41*	**56**	64	59	56	51
CP07	Transport	*158*	**139**	91	120	154	160
	of which:						
	Diesel	*18*	**18**	12	19	20	19
	Petrol	*16*	**16**	16	19	17	15
CP08	Communication	*41*	**38**	48	44	37	31
CP09	Culture and spare time	*90*	**88**	69	76	89	104
CP10	Education	*10*	**9**	3	5	9	13
CP11	Accommodation, restaurants and cafés	*79*	**81**	53	74	80	96
CP12	Personal care and services	*87*	**109**	113	120	105	104
	Total	*1 000*	**1 000**	1 000	1 000	1 000	1 000
	Share of motor fuels, alcoholic beverages and tobacco (in %)	*5.9*	**5.9**	6.2	6.5	6.2	5.3

Sources: HBS 2018, own calculations.

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Abstracts from the Working Papers series

389. The political economic of financing climate policy: evidence from the solar PV subsidy programs, by O. De Groote, A. Gauier, F. Verboven, October 2020

To combat climate change, governments are taking an increasing number of technology-specific measures to support green technologies. In this paper, the authors look at the very generous subsidy policies for solar PVs in the three Regions of Belgium to ask the question of how voters responded to these programs. They provide evidence that voters did not reward the incumbent government that was responsible for the program, as predicted by the 'buying-votes' hypothesis. Instead, they find that voters punish the incumbent government because of the increasing awareness of the high financing costs.

These not only affected the non-adopting electricity consumers who did not benefit from the programs, but also the adopting prosumers, who saw unannounced new costs such as the introduction of prosumer fees to get access to the grid.

390. Going green by putting a price on pollution: Firm-level evidence from the EU, by O. De Jonghe, K. Mulier, G. Schepens, October 2020

This paper shows that, when the price of emission allowances is sufficiently high, emission trading schemes improve the emission efficiency of highly polluting firms. The efficiency gain comes from a relative decrease in emissions rather than a relative increase in operating revenue. Part of the improvement is realised via the acquisition of green firms. The size of the improvement depends on the initial allocation of free emission allowances: highly polluting firms receiving more emission allowances for free, such as firms on the carbon leakage list, have a weaker incentive to become more efficient. For identification, the authors exploit the tightening in EU ETS legislation in 2017, which led to a steep increase in the price of emission allowances and made the ETS Directive more binding for polluting firms.

391. Banking barriers to the green economy, by H. Degryse, T. Roukny, J. Tielens, October 2020

In the race against climate change, financial intermediaries hold a key role in rapidly redirecting resources towards greener economic activities. However, this transition entails a dilemma for banks: entry of innovative and green firms into polluting industries risks devaluing legacy positions held with incumbent clients. As a result, banks exposed to such losses may be reluctant to finance innovation to reduce polluting activities such as greenhouse gas emissions. In this paper, the authors formalise potential banking barriers to investment in green firms that threaten the value of legacy contracts by affecting collateral pledged by incumbent clients to banks as well as probabilities of default. The authors show that the more homogeneous and concentrated the banking system is in a given industry, the fewer new innovative firms will be granted loanable funds. The authors further exploit data on credit allocations in Belgium between 2008 and 2018, to investigate the empirical relevancy of such barriers in polluting industries with larger exposures to green technology disruption. The results indicate that the market structure of the banking system may be key to facilitating a green economic transition highlighting the need for policies to address the role of brown legacy positions and heterogeneous bank business models.

392. When green meets green, by H. Degryse, R. Goncharenko, C. Theunisz, T. Vadasz, October 2020

What is the impact of environmental consciousness (i.e. being green) as borrower and as lender on loan rates? The authors investigate this question by using an international sample of syndicated loans over the period 2011-2019. They find that green firms borrow at a significantly lower spread, especially when the lender consortium can also be classified as green, i.e., when "green-meets-green". Further tests reveal that the impact of "green-meets-green" became significant and largely negative only after the acceptance of the Paris Agreement in December 2015. The authors argue that this is evidence for lenders responding to policy events which affect environmental attitudes.

393. Optimal climate policy in the face of tipping points and asset stranding, by E. Campiglio, S. Dietz, F. Venmans, October 2020

The authors have studied the optimal transition to a low-carbon economy, recognizing that the transition is not going to be seamless as it implies adjustment costs. They find that introducing costs to repurposing dirty capital as clean leads to a slower decline of emissions initially, which, given temperature is a linear function of cumulative CO2 emissions, leads to the need for greater emissions reductions later. These frictions thus optimally push abatement effort further into the future, with as result higher carbon prices to get the right incentive to incur the extra costs. The share of genuinely dirty capital in the economy – capital that requires fossil fuels to produce goods and services – is actually quite small, a point that can be substantiated using data from multi-regional input-output tables, which likely overstate the share of dirty capital, even. Therefore the value of assets repurposed or 'stranded' in this way is rather small. Delaying the introduction of the globally optimal carbon tax by a decade or two, which can be seen as an approximation of continued difficulties in negotiating and implementing a sufficiently strong set of national climate commitments, increases this value of stranded assets. A delay of 2 decades leads to a decrease in welfare of 0.71 %, a cost of $ 108.5 trillion dollar at current prices. In view of avoiding stranding assets, governments could institute a combination of taxes on dirty capital investment and subsidies on clean capital investment, instead of imposing a Pigouvian tax on CO2 emissions. The authors quantify the welfare cost of this second-best policy and we find that welfare is reduced by 0.2 %, i.e. $ 25 Trillion at current prices.

394. Are green bonds different from ordinary bonds? A statistical and quantitative point of view, by C. Ma, W. Schoutens, J. Beirlant, J. De Spiegeleer, S. Höcht, R. Van Kleeck, October 2020

A green bond is a type of fixed-income security that raises money to invest in predetermined climate and environmental projects, in contrast to conventional debt instruments, where the use of proceeds is not specified in the terms. The difference in yield between a green bond and an otherwise identical non-green bond from the same issuer and with the same terms is called the greenium. In this paper, the authors investigate this yield differential between green and conventional bonds. The authors estimate the greenium on the basis of the bond's asset swap spread (ASW) to investigate whether, consistent with a non-pecuniary motive for holding green assets, green labels are associated with a negative or positive yield gap with respect to ordinary bonds. They calculate and compare several descriptive statistics on green bonds and conventional bonds. Then, several statistical tests are implemented to analyse potential statistical differences between their return distributions. In their analysis, synthetic non-green bonds are constructed via interpolation of the ASW curve of non-green bonds. There are several findings: (1) From a statistical point of view, no difference between the overall distribution, the mean or median of ASW changes is detected on individual bond pairs. However, their estimation of an overall greenium exhibits a level fluctuating near zero over time with an overall average around –7 bps. (2) In addition, the authors see indications that the volatility of some green bonds is lower than their non-green counterparts. (3) They see a lagging effect between the greenium and stress in financial markets. This could indicate that sustainable investment like green bonds is potentially more immune to systemic crises.

395. Climate change concerns and the performance of green versus brown stocks, by D. Ardia, K. Bluteau, K. Boudt, K. Inghelbrecht, October 2020

The authors empirically test the prediction of Pastor, Stambaugh, and Taylor 2020 that green firms can outperform brown firms when climate change concerns strengthen unexpectedly for S&P 500 companies over the period January 2010 – June 2018. To capture unexpected increases in climate change concerns, the authors have constructed a Media Climate Change Concerns index using climate- change-related news published by major US newspapers. They find a negative relationship between the firms' exposure to the Media Climate Change Concerns index and the level of the firm's greenhouse gas emission per unit of revenue. This result implies that when concerns about climate change rise unexpectedly, green firms' stock price increases, while brown firms' stock price decreases. Further, using topic modelling, the authors analyse which type of climate change news drives this relationship. They identify five themes that have an effect on green vs. brown stock returns. Some of those themes can be related to changes in investors' expectations about the future cash flow of green vs. brown firms, while others cannot. This result implies that the relationship between concern about climate change and green vs. brown stock returns arises from both investors updating their expectations about the future cash flows of green and brown firms and changes in investors' sustainability taste.

Conventional signs

%	per cent
e.g.	*exempli gratia*
et al.	*et alia* (and others)
etc.	*et cetera*
excl.	excluding
i.e.	*id est* (that is)
incl.	including
mio	million
p.m.	*pro memoria*
p.p.	percentage point

List of abbreviations

Countries or regions

BE	Belgium
DE	Germany
EE	Estonia
IE	Ireland
EL	Greece
ES	Spain
FR	France
IT	Italy
CY	Cyprus
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
AT	Austria
PT	Portugal
SI	Slovenia
SK	Slovakia
FI	Finland
EA	Euro area
CZ	Czech Republic
DK	Denmark
HR	Croatia
PL	Poland
SE	Sweden
EU	European Union (including UK depending on the period considered)
EU28	European Union of 28 countries (still including UK)
AU	Australia
CA	Canada
CH	Switzerland
CN	China
IL	Israel
IS	Iceland
KR	Korea
NO	Norway

JP	Japan
SG	Singapore
TW	Taiwan
UK	United Kingdom
US	United States

Other abbreviations

AI	Artificial intelligence
AIReF	Independent Authority of Fiscal Responsibility
CBR	Council for Budget Responsibility
CCL	Climate Change Levy
CETA	Comprehensive Economic and Trade Agreement
CFP	Public Finance Council
CO_2	Carbon dioxide
COICOP	Classification of Individual Consumption by Purpose
COVID-19	Disease caused by coronavirus SARS-CoV-2
CPB	Bureau for Economic Policy Analysis
CPC	Cooperative Patent Classification
CPI	Consumer price index
CPS	Carbon Price Support
DNB	De Nederlandsche Bank
EC	European Commission
ECB	European Central Bank
EEA	European Economic Area
EPO	European Patent Office
EPC	Economic Policy Council
ERMG	Economic Risk Management Group
ESA	European System of Accounts
ESCB	European System of Central Banks
ETS	Emissions Trading System
Eurostat	European Statistical Office
FDI	Foreign direct investment
FISK	Fiscal Advisory Council
FPB	Federal Planning Bureau
FPS	Federal Public Service
FPS BOSA	Federal Public Service Policy and Support
FRI	Fiscal Rule Index
FRSI	Fiscal Rule Strength Index
GDP	Gross domestic product
GCEE	German Council of Economic Experts

HAN	Harmonised patent applicants' names
HBS	Household Budget Survey
HCF	High Council of Finance
HCFP	High Council of Public Finances
HICP	Harmonised index of consumer prices
IAM	Integrated assessment macromodels
IEA	International Energy Agency
ICT	Information and communication technology
IFAC	Irish Fiscal Advisory Council
IGEC	Intergovernmental Group of Experts on Climate Change
IMEC	Interuniversity Microelectronics Centre
IMF	International Monetary Fund
INSEE	*Institut national de la statistique et des études économiques* (French statistical institute)
IP	Intellectual property
IPC	International Patent Classification
IPCC	International Panel on Climate Change
IRES	*Institut de Recherches Economiques et Sociales*
JPO	Japan Patent Office
KEINS	Knowledge-based Entrepreneurship: Innovation, Networks and Systems, European Union
$kgCO_2$	kilogrammes of CO_2
MLT	Medium-term projection
MTO	Medium-term objective
Mtoe	Million tonnes of oil equivalent
Mtonnes	million tonnes
NACE	Nomenclature of economic activities of the European Community
NAI	National Accounts Institute
NBB	National Bank of Belgium
NBER	National Bureau of Economic Research
NCPI	National consumer price Index
NEIG	Non-energy industrial goods
NEO	National Employment Office
OECD	Organisation for Economic Cooperation and Development
PATSTAT	Worldwide Statistical Patent Database (EPO)
PBO	Parliamentary Budget Office
PCT	Patent Cooperation Treaty
ppm	parts per million
PPP	Purchasing power parity
R&D	Research and development

rhs	Right-hand scale
RIZIV-INAMI	National Institute for Health and Disability Insurance
RSZ-NSSO	National Social Security Office
RSVZ-INASTI	National Institute for the Social Security of the Self-employed
RTA	Revealed technological advantage
SBR	*Studiegroep Begrotingsruimte* (Study group on the fiscal space)
SME	Small and medium-sized enterprise
Statbel	Belgian Statistical Office
STEM	Science, technology, engineering and mathematics
tCO_2	tonnes of CO_2
TICPE	*Taxe intérieure sur la consommation de produits energétiques* (French carbon tax)
TSCG	Treaty for Stability, Coordination and Governance in the Economic and Monetary Union
USPTO	United States Patent and Trademark Office
VAT	Value added tax
VIB	*Vlaams instituut voor biotechonologie*
VITO	*Vlaamse Instelling voor Technologisch Onderzoek*
VRT	*Vlaamse Radio- en Televisieomroeporganisatie*
WGPF	Working Group on Public Finance of the European System of Central Banks
WIPO	World Intellectual Property Organization
WTO	World Trade Organisation

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