Banc Ceannais na hÉireann
Central Bank of Ireland

Eurosystem

Quarterly Bulletin

QB1 – January 2022

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Notes

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2. Unless otherwise stated, statistics refer to the State, i.e., Ireland exclusive of Northern Ireland.

3. In some cases, owing to the rounding of figures, components do not add to the totals shown.

4. The method of seasonal adjustment used in the Bank is that of the US Bureau of the Census X-11 variant.

5. Annual rates of change are annual extrapolations of specific period-to-period percentage changes.

6. The following symbols are used:

e	**estimated**
n.a.	**not available**
p	**provisional**
. .	**no figure to be expected**
r	**revised**
–	**nil or negligible**
q	**quarter**
f	**forecast**

7. Data on euro exchange rates are available on our website at www.centralbank.ie and by telephone at 353 1 2246380.

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Comment

Despite the emergence of the Omicron wave of Covid-19 and the related increase in uncertainty, the economy overall is proving resilient. In the coming years, continued strong growth in output and employment are forecast, with the economy converging on its potential level of activity. Each wave of the pandemic has had progressively weaker effects on demand, albeit that conditions in more contact-intensive sectors remain constrained. As both the global and domestic economy adjust, supply conditions have been slower to normalise. These forces have contributed to higher consumer prices, and inflation is forecast to remain above the low levels seen in the decade between the financial crisis and the pandemic. However, inflation is expected to ease from current levels, as acute pandemic-related effects and energy price growth diminish in importance.

The economy continued to pick up momentum during most of the second half of 2021, with strong employment growth and domestic spending. The level of public health restrictions during late 2021 and early 2022 has been higher than expected at the time of our *Bulletin* in October due to the emergence of the Omicron variant of Covid-19. While the disruption of recent weeks will have dampened the pace of recovery, it has not derailed it. With recent changes in public-health requirements, and greater clarity on the epidemiological situation, the challenges to the supply side of the economy should ease (Box C). The central forecast in this *Bulletin* sees a more rapid reduction in the unemployment rate over the coming years than in previous forecasts. Moreover, there will likely be quite different experiences across sectors depending on their experience through the pandemic. The ability to adapt or recover lost ground in light of changes in consumer and investor preferences, technology and ways of working, and supply chains will not be uniform across the economy.

The overall strength of the labour market recovery has been encouraging. Adjustment through the pandemic has resulted in more people in

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employment by Q3 2021 compared with prior to the pandemic, particularly females and younger workers. Indeed female labour force participation is at its highest level on record in Ireland, with this increase being driven by those with a third-level education entering full-time jobs in high-skilled sectors (Box G). It remains to be seen how persistent some of these recent trends will be.

Relative changes in labour demand and supply through the pandemic have led to some wage pressures at the same time as a significant number of firms, most notably in the hospitality sector, continue to avail of the wage subsidy scheme. The extent to which wage pressures become more generalised, especially in sectors with relatively low productivity growth, how firms adjust to the eventual unwinding of the wage subsidy scheme, and how migration responds in the years ahead are all issues that will affect labour market conditions and the pace at which the economy reaches capacity constraints.

Disruption to global supply chains, surging demand and the rise in energy prices remain key factors in explaining the higher rates of consumer price inflation in Ireland and the euro area. These are expected to remain relevant over much of 2022, but still to ease later in the year. Headline increases in consumer prices during 2021 can be accounted for by shocks to the relative prices of particular goods and services, especially energy and rents (Box E). However, price dynamics have started to strengthen in some contact-intensive sectors most heavily affected by the pandemic, while, as the labour market tightens, the potential exists for second-round effects through higher wages and other business costs being passed through to consumer prices in the years ahead. Therefore, while the rate of inflation is expected to decline, it will remain above pre-pandemic levels and risks to the inflation forecast are judged to be on the upside.

Higher inflation and the pace of expected income growth this year points to a reduction in real purchasing power overall. This will be experienced to different degrees across households, especially as energy and rents typically make up a higher proportion of expenditure by lower income households. With the emergence of further and more broad-based wage growth over time, real incomes are expected to rise through 2023 and 2024. This, along with the expected reduction in the savings ratio, will support higher household spending, and domestic demand is forecast to contribute proportionately more to economic growth in the coming years. On balance, risks to the growth forecast are marginally to the upside. The

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potential of a more rapid growth in consumption and investment amidst a tighter labour market outweighs that of other risks which could have more negative economic effects, such as more persistent Covid-related uncertainty or sector-specific challenges arising from Brexit.

The resilience of the economy through the pandemic, alongside positive surprises in corporation tax revenues, has seen the public finances recover markedly. With the favourable economic outlook over the coming years, a surplus on the General Government Balance is now expected to emerge sooner, in 2023, with a larger surplus and related improvement in the debt position in 2024. This relatively positive position offers an opportunity to ensure that the overarching fiscal framework remains appropriate, and can sustainably support domestic macro-financial stability while addressing priorities for the community as a whole. The work of the Commission on Taxation and Welfare, expected to be completed by July 2022, is timely in this respect.

Economic policy frameworks are changing to support households, businesses and wider society to adapt to challenges from both extreme weather events and in transitioning to a less carbon-intensive economy. In doing so, our analytical framework and evidence-base to support economic policy is also evolving. Domestically, the introduction of sector specific emissions targets, retro-fitting schemes and increases in carbon tax over time, are amongst the measures being introduced. Measured on the basis of emissions per employment, the carbon intensity of the Irish economy is high in an EU context (Box H). Significant action will be needed, especially in carbon-intensive sectors, for Ireland to meet the targets set for 2030. Understanding how the economy is adjusting as a result of climate change and climate action is important for monetary policy, as acknowledged in the recent ECB Strategy Review. A *Signed Article* accompanying this *Bulletin* outlines the key channels through which climate change and the climate transition affect the economy. The *Article* describes how the analytical framework both at the Central Bank of Ireland and at central banks more generally, is evolving to inform policy.

Sustainably addressing the challenges of climate change and other infrastructure deficits, most notably in the area of housing, remains a key challenge for public policy as the economy transitions to a more settled existence with Covid-19 and emergency supports are unwound. With the economy likely to approach capacity limits through 2023, planned or necessary public expenditure on priorities such as climate action, housing

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or healthcare will have to be carefully managed. The overall stance or composition of fiscal policy may have to be adjusted to avoid excessive inflationary pressures. Sustainably addressing challenges in housing will be important in maintaining Ireland's competitiveness and relative attractiveness as a place to live, work and do business. Such action would also reinforce resilience in the public finances and the broader economy, enhancing the ability to respond to future shocks.

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An Timpeallacht Gheilleagrach

D'ainneoin theacht chun cinn ráig Omicron de COVID-19, agus d'ainneoin ghéarú gaolmhar na héiginnteachta, is léir go bhfuil an geilleagar foriomlán sách athléimneach. Sna blianta atá le teacht, tuartar go leanfaidh fás láidir ar aschur agus ar fhostaíocht, agus go mbeidh an geilleagar ar tarraingt ar leibhéal ionchasach a ghníomhaíochta. Ba laige de réir a chéile na héifeachtaí a bhí ag gach ráig den phaindéim ar éileamh, cé go bhfuil srian i gcónaí le dálaí in earnálacha dianteagmhála. De réir mar atá an geilleagar domhanda agus intíre ag dul in oiriúint don staid seo, tá na dálaí soláthair níos moille ag teacht chucu féin arís. Tá na fórsaí seo ag cur le praghsanna níos airde do thomhaltóirí, agus tuartar go bhfanfaidh an boilsiú os cionn na leibhéal íseal atá feicthe le deich mbliana anuas, le linn na tréimhse ón ngéarchéim airgeadais go dtí an phaindéim. Meastar go laghdóidh an boilsciú ó na leibhéil atá ann faoi láthair, áfach, de réir mar a mhaolóidh an tábhacht a bhaineann le héifeachtaí géara na paindéime agus leis an bhfás ar phraghas fuinnimh.

Lean an geilleagar ag bailiú nirt le linn an dara leath de 2021 sa mhéid go bhfacthas fás láidir ar fhostaíocht agus ar chaiteachas intíre. Bhí leibhéal na srianta sláinte poiblí níos airde i dtreo dheireadh 2021 agus go luath in 2022 ná mar a bhíothas ag súil leis tráth a foilsíodh an *Fhaisnéis Ráithiúil* deiridh i mí Dheireadh Fómhair de bharr athraitheach Omicron de COVID-19. Cé go bhfuil luas an téarnaimh maolaithe ag an suaitheadh le seachtainí beaga anuas, níl sé curtha dá bhoinn. Leis na hathruithe a rinneadh le déanaí ar riachtanais sláinte poiblí, mar aon le soiléireacht níos fearr ar an staid eipidéimeolaíochta, ba cheart go maolódh na dúshláin don gheilleagar ó thaobh an tsoláthair de (Bosca C). Sa réamhaisnéis lárnach san *Fhaisnéis Ráithiúil* seo, tuartar laghdú níos tapúla ar an ráta dífhostaíochta sna blianta atá le teacht ná mar a tuaradh i réamhaisnéisí roimhe seo. Thairis

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sin, is dócha go mbeidh taithí éagsúil i gceist sna hearnálacha éagsúla, ag brath ar an taithí a bhí acu le linn na paindéime. Níl an cumas oiriúnaithe nó an cumas chun an bhris a thabhairt isteach aonfhoirmeach ar fud an gheilleagair i bhfianaise athruithe ar roghanna tomhaltóirí agus roghanna infheisteoirí, ar theicneolaíocht agus ar mhodhanna oibre, agus ar shlabhraí soláthair.

Is údar misnigh é neart foriomlán an téarnaimh ar an margadh saothair. Le coigeartú le linn na paindéime, bhí níos mó daoine fostaithe faoi R3 2021 i gcomparáid leis an líon daoine a bhí fostaithe roimh an bpaindéim, go háirithe baineannaigh agus oibrithe níos óige. Go deimhin, tá rannpháirtíocht na mban san fhórsa saothair ag an leibhéal is airde ar taifead in Éirinn, agus tá an méadú seo á spreagadh ag dream a bhfuil oideachas tríú leibhéal acu agus atá ag dul i mbun poist lánaimseartha in earnálacha ardoilte. Ní fios go fóill cé chomh dianseasmhach a bheidh roinnt de na treochtaí atá feicthe le déanaí.

Tá brúnna pá cruthaithe ag athruithe coibhneasta ar an éileamh ar shaothar le linn na paindéime, an tráth céanna atá líon suntasach gnólachtaí, go háirithe san earnáil fáilteachais, ag baint leas as an scéim fóirdheontais pá. A mhéid a thiocfaidh brúnna pá chun cinn ar bhonn níos ginearálta, go háirithe in earnálacha ina bhfuil fás sách íseal ar tháirgiúlacht, an chaoi a rachaidh gnólachtaí in oiriúint do scaoileadh na scéime fóirdheontais pá ar deireadh thiar, agus cad a tharlóidh le himirce sna blianta atá romhainn - is saincheisteanna iad sin go léir a dhéanfaidh difear do dhálaí an mhargaidh saothair agus don luas faoina sroicfidh an geilleagar srianta acmhainneachta.

Is tosca ríthábhachtacha iad i gcónaí an cur isteach ar shlabhraí soláthair domhanda, an borradh ar éileamh agus an méadú ar phraghsanna fuinnimh ó thaobh míniú a thabhairt ar ardrátaí an bhoilscithe i bpraghsanna do thomhaltóirí in Éirinn agus sa limistéar euro. Meastar go mbainfidh siad seo le hábhar le linn 2022 ach go maolóidh siad níos déanaí sa bhliain. Tá na príomh-mhéaduithe ar phraghsanna do thomhaltóirí inchurtha do thurraingí do phraghsanna coibhneasta earraí agus seirbhísí ar leith, go háirithe fuinneamh agus cíosanna (Bosca E). Ar a shon sin, tá dinimic praghsanna ag neartú i roinnt de na hearnálacha dianteagmhála atá buailte go mór ag an bpaindéim, fad atá an fhéidearthacht ann, de réir mar a ghéaraíonn an brú ar an margadh saothair, go mbeidh éifeachtaí neamhdhíreacha ann de bharr pánna níos airde agus costais gnó a bheith curtha ar aghaidh chuig praghsanna do thomhaltóirí sna blianta atá

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romhainn. Dá bhrí sin, cé go meastar go laghdóidh an ráta boilscithe, fanfaidh sé os cionn na leibhéal a bhí ann roimh an bpaindéim agus breithnítear go bhfuil na rioscaí do réamhaisnéis an bhoilscithe ar an taobh thuas.

Le boilsciú níos airde agus luas an fháis mheasta ar ioncam i mbliana, tugtar le tuiscint go mbeidh laghdú ar an bhfíorchumhacht ceannaigh fhoriomlán. Beidh sé seo le brath ag leibhéil éagsúla i dteaghlaigh éagsúla, go háirithe toisc gur cion níos mó de chaiteachas na dteaghlach ísealioncaim iad fuinneamh agus cíosanna de ghnáth. De réir mar a thiocfaidh fás pá chun cinn ar bhonn níos leithne le himeacht ama, meastar go méadóidh fíorioncam le linn 2023 agus 2024. I dteannta an laghdaithe mheasta ar an gcóimheas coigiltis, tacóidh sé seo le caiteachas níos airde na dteaghlach, agus tuartar go gcuirfidh an t-éileamh intíre le fás eacnamaíoch ar bhonn níos comhréirí sna blianta atá le teacht. Tríd is tríd, tá na rioscaí don réamhaisnéis fáis beagáinín ar an taobh thuas. Is treise an t-ionchas d'fhás níos tapúla ar thomhaltas agus ar infheistíocht ná rioscaí eile a d'fhéadfadh éifeachtaí eacnamaíocha níos diúltaí bheith acu, amhail éiginnteacht níos seasmhaí a bhaineann le COVID nó dúshláin a eascraíonn as Brexit agus atá sonrach ó thaobh earnála de.

Tá téarnamh suntasach tagtha ar an airgeadas poiblí i bhfianaise athléimneacht an gheilleagair le linn na paindéime, i dteannta ábhair iontais dhearfacha ó thaobh ioncaim ó cháin chorparáide. Leis an ionchas eacnamaíoch fabhrach sna blianta atá le teacht, meastar go dtiocfaidh barrachas ar an Iarmhéid Rialtais Ghinearálta chun cinn níos luaithe ná mar a bhíothas ag súil leis, in 2023, agus go bhfeicfear barrachas níos mó agus feabhas gaolmhar ar an staid fiachais in 2024. Leis an staid sách dearfach seo, tá an deis ann a chinntiú gur cuí i gcónaí an creat uileghabhálach fioscach, agus gur féidr leis tacú ar bhonn inbhuanaithe le cobhsaíocht macra-airgeadais intíre fad a thabharfaidh sé aghaidh ar na tosaíochtaí don phobal i gcoitinne. Chuige seo, is tráthúil obair an Choimisiúin um Chánachas agus Leas a a chuirfear i gcrích faoi Iúil 2022.

Tá athrú ag teacht ar chreata beartais eacnamaíoch chun tacú le teaghlaigh, gnóthaí agus leis an tsochaí níos leithne chun dul in oiriúint do dhúshláin ó eachtraí adhaimsire agus ón aistriú go dtí geilleagar a mbeidh lorg carbóin níos ísle aige. Lena linn sin, tá forbairt ag teacht freisin ar ár gcreat anailíseach agus ár mbonn fianaise chun tacú le beartas eacnamaíoch. Sa chríoch baile, tá spriocanna d'astaíochtaí atá sonrach ó thaobh earnála de, scéimeanna iarfheistithe agus méaduithe ar cháin

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charbóin le himeacht ama, i measc na mbeart ata á dtabhairt isteach. Agus í á tomhas ar bhonn astaíochtaí in aghaidh fostaíochta, tá déine carbóin gheilleagar na hÉireann ard i gcomhthéacs AE (Bosca H). Beidh gá le gníomhaíocht shuntasach, go háirithe in earnálacha a bhfuil lorg mór carbóin acu, chun go mbeidh Éire in ann na spriocanna a leagadh síos do 2030 a bhaint amach. Tá sé riachtanach don bheartas airgeadaíochta go dtuigfear an chaoi ina bhfuil coigeartú á dhéanamh ar an ngeilleagar mar thoradh ar an athrú aeráide agus ar na gníomhaíochtaí ar son na haeráide, rud a aithníodh san Athbhreithniú a rinneadh le déanaí ar Straitéis an BCE. In *Alt Sínithe* a ghabhann leis an bh*Faisnéis Ráithiúil* seo, leagtar amach na príomhbhealaí trína ndéanann athrú aeráide agus aistriú aeráide difear don gheilleagar. San Alt sin, cuirtear síos ar an gcaoi ina bhfuil forbairt ag teacht ar an gcreat anailíseach i mBanc Ceannais na hÉireann agus i mbainc cheannais i gcoitinne, d'fhonn beartas a fhoirmiú.

Is príomhdhúshlán i gcónaí don bheartas poiblí é dul i ngleic le dúshláin an athraithe aeráide agus easnaimh bonneagair, go háirithe i réimse na tithíochta, de réir mar a aistríonn an geilleagar chuig saol sochair le COVID-19, agus de réir mar a chuirtear deireadh le tacaíochtaí éigeandála. Ó tharla gur dócha go mbeidh an geilleagar ag druidim i dtreo a lánacmhainneachta le linn 2023, ní mór caiteachas poiblí atá beartaithe nó riachtanach ar thosaíochtaí amhail gníomhú ar son na haeráide, tithíocht nó cúram sláinte, a bhainistiú go cúramach. Féadfaidh gur gá staid nó comhdhéanamh iomlán an bheartais fhioscaigh a choigeartú chun brúnna boilscitheacha iomarcacha a sheachaint. Beidh sé tábhachtach dul i ngleic go cuí le dúshláin tithíochta chun iomaíochas agus tarraingtheacht choibhneasta na hÉireann a chothabháil mar áit chónaithe, áit oibre agus áit le gnó a sheoladh. Le gníomhaíocht den sórt sin, dhéanfaí athléimneacht an airgeadais phoiblí agus an gheilleagair níos leithne a athneartú freisin, rud a d'fheabhsódh an cumas chun freagairt do thurraingí amach anseo.

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The Irish Economy

Overview

The Irish economy recovered strongly in 2021, despite headwinds from the pandemic, a slowdown in global trade and an increase in inflation. Modified Domestic Demand is estimated to have grown by 5.5 per cent, ending the year above its pre-pandemic level. The recovery has primarily been driven by consumption, as pandemic-related restrictions eased in the third and fourth quarters of the year.

In the first quarter of 2022, economic activity is expected to be weaker than previously anticipated due to the emergence of the Omicron variant which led to a renewal of some restrictions and heightened uncertainty about the duration of the pandemic. The economic impact of this wave is forecast to be smaller than that of previous waves, as households and firms have adapted to the pandemic and high vaccination rates have reduced the risk from infection. Changes to guidance on self-isolation for close contacts, which had a significant effect on the labour market in January, will further mitigate the impact (see Box C). The *Bulletin* projections assume that the effect of the pandemic on economic output will continue to diminish over the forecast horizon.

The economy is forecast to continue to grow strongly over the projection horizon (Figure 1). Modified Domestic Demand is forecast to expand by more than 17 per cent from 2022 to 2024, buoyed in the main by a recovery in personal consumption. Consumption will be supported by growth in disposable incomes, the normalisation of savings rates, and the unwinding of some savings accumulated during the pandemic.

Many of the factors causing the currently high headline inflation rate are expected to wane in the second half of 2022, but the inflation rate is forecast to remain above pre-pandemic levels throughout the projection horizon (Figure 2). More stable energy prices, and the dissipation of post-pandemic supply chain disruption, is forecast to bring the inflation rate down from the second half of 2022. As domestic economic activity approaches its pre-crisis trend in 2023 and 2024, inflation is forecast to remain above its 2019 level.

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Employment is forecast to grow by a cumulative 6.9 per cent between 2022 and 2024, generating 167,000 new jobs and bringing the unemployment rate down to 4.6 per cent by end-2024. Employment grew by 5.5 per cent in 2021, and labour force participation increased strongly. Some factors relating to the pandemic (remote working, lower migration) may subside over the forecast horizon. The unemployment rate is forecast to average 4.9 per cent in 2024.

Trade will continue to be dominated by ICT services and pharmaceuticals. The continued expansion of output in these sectors, coupled with production abroad on behalf of Irish firms in these sectors, will drive strong export growth over the forecast horizon. Exports by Irish-owned resident firms are expected to grow in-line with global demand. Accordingly, the underlying trade balance will continue to remain in surplus over the projection horizon.

The eventual implementation of post-Brexit checks on Irish exports to the UK will likely cause a reduction in the exports of some sectors, particularly agri-food. The UK has recently delayed the planned implementation of border checks and tariffs on goods coming from Ireland. This has resulted in an upward revision to the outlook for merchandise exports in 2022. However, these checks will eventually be implemented and will likely reduce Ireland-UK exports.

Both the deficit and debt position of the Government start 2022 in a better position than previously anticipated, with further improvement expected over the forecast horizon. A General Government surplus is expected to emerge next year, rising to 1.8 per cent of GNI* in 2024. Meanwhile General Government Debt is forecast to be 85 per cent of GNI* in 2024.

The risks to the projection remain tilted to the upside. Stronger domestic demand supported by the use of savings built-up during the pandemic, or a faster than expected recovery in the global economy, could pose upside risks to the growth forecast. The economy could face broader capacity constraints sooner than anticipated, either through demand conditions growing more rapidly or supply constraints adjusting at a slower pace than anticipated. In both instances, inflation could be higher than the current forecast.

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Table 1: Macroeconomic Projections for the Irish Economy

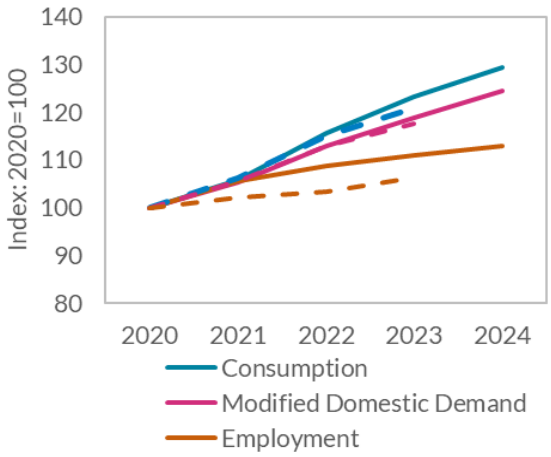
(annual percentage changes – constant prices)

	2021e	2022f	2023f	2024f
Modified Domestic Demand	5.5	7.1	5.2	4.8
Gross Domestic Product	16.1	8.7	5.0	6.0
Personal Consumer Expenditure	5.8	9.4	6.5	4.9
Public Consumption	5.1	-0.3	-1.1	1.6
Gross Fixed Capital Formation	-47.3	7.1	6.5	6.3
Modified Gross Fixed Capital Formation	5.0	8.6	7.9	7.4
Exports of Goods and Services	17.5	9.0	6.2	5.7
Imports of Goods and Services	-8.9	8.0	7.0	4.9
Total Employment (% change)	5.5	3.1	2.1	1.7
Unemployment Rate	6.4	5.8	5.3	4.9
Harmonised Index of Consumer Prices (HICP)	2.4	4.5	2.4	2.1
HICP Excluding Energy	1.5	3.3	2.6	2.2
Compensation per Employee	2.3	3.3	4.5	5.0
General Government Balance (% GNI*)	-3.7	-1.5	1.3	1.8
General Government Gross Debt (%GNI*)	102.1	92.7	89.0	84.9

1 . GDP is reported here, as it is the standard measure used in international comparison and forms Ireland's contribution to the Eurosystem staff projections. Caution should be used in interpreting GDP developments for Ireland, as it is heavily influenced by globalisation and the activities of multinational enterprises.
2. A more detailed set of forecasts are available on our website.

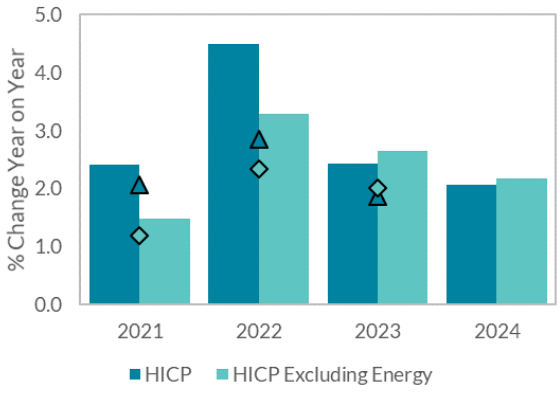
The economy will continue to grow strongly, and inflation will begin to moderate this year

Figure 1: Consumption, MDD and Employment



Source: CSO and Central Bank of Ireland
Note: Dashed lines indicate forecast from QB4 (Oct 2021)

Figure 2: HICP Inflation



Source: CSO
Note: Markers indicate forecast from QB4 (Oct 2022)

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Box A: The International Economic Outlook

By the Monetary Policy Division

The global economic outlook is expected to remain positive, owing to a strong recovery in 2021, with both monetary and fiscal policies set to remain generally supportive in 2022. However, with the future of the pandemic remaining uncertain and the continuing potential for new Covid-19 variants to emerge, the pace and distribution of growth across countries will depend on the global rollout and uptake of vaccines and boosters. The latest forecasts from the OECD shows while lower-income countries are highly unlikely to see output reaching pre-pandemic expectations, the output of advanced economies is expected to converge to pre-pandemic trajectories.[1] The OECD highlights that differences in vaccination rates are contributing to the imbalance in economic recovery. Higher income countries are more advanced along their respective vaccination programmes and this should help to spur the normalisation of demand patterns in those economies. An imbalanced labour market has also led to an uneven recovery not just among lower-income countries, but also across advanced economies as certain sectors are experiencing labour shortages despite employment and hours worked having not yet fully recovered in many instances. Common to all economies are higher energy prices and inflationary pressure stemming from a rising demand for goods struggling to be fulfilled against constricted production chains. Such bottlenecks are expected to fade over time. The latest OECD projections, released in December 2021, forecast global growth to moderate from 5.6 per cent in 2021 to 4.5 per cent in 2022 and 3.2 per cent in 2023.

Euro area seasonally-adjusted Gross Domestic Product (GDP) grew by 2.2 per cent in the third quarter of 2021, when compared with the previous quarter. This follows the same growth of 2.2 per cent in the second quarter of 2021. Forecasts for the euro area published by the ECB in December 2021 revised short-term growth downward compared with September 2021 projections, due largely to more restrictive public health measures and global supply bottlenecks. However, these headwinds are expected to dissipate in the second quarter of 2022, facilitating a bounce-back that should see real GDP by the end of 2022 surpassing the level foreseen at the time of the September 2021 ECB projections. The December projections include euro area real GDP growth of 5.1 per cent in 2021 (up from the September forecast of 5.0 per cent), by 4.2 per cent in 2022 (down from 4.6 per cent) and by 2.9 per cent in 2023 (up from 2.1 per cent). In December, the euro area Purchasing Managers Index (PMI) Composite Output Index, compiled by Markit, decreased to 53.3, from 55.4 in November. This indicates a nine-month low in

[1] It should be noted that these predictions were estimated prior to the emergence of the Omicron variant.

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economic growth, as the euro area experienced a resurgence in Covid-19 infections and the spread of the Omicron variant. Similarly, the Services PMI decreased from 55.9 in November, to 53.1 in December. Manufacturing growth fell to 58.0 during December, down from 58.4 in November and its lowest reading in ten months.

Euro area headline inflation, as measured by the year-on-year increase in the Harmonised Index of Consumer Prices, is estimated to be 5.0 per cent in December, up from 4.9 per cent in November. Looking at the main components of euro area inflation, energy is estimated to have the highest annual rate in December (26.0 per cent, compared with 27.5 per cent in November), followed by food, alcohol and tobacco (3.2 per cent, compared with 2.2 per cent in November). Euro area core inflation is estimated to be 2.6 per cent in December, unchanged from November. Eurosystem staff projections expect inflation to be higher for longer than previously estimated but anticipate a sharp decline in 2022, as higher energy price inflation subsides and supply catches up with demand. Consequently, the annual HICP inflation for the euro area is forecast to average 3.2 per cent in 2022 (up from 1.7 per cent in September) and 1.8 per cent in 2023 (up from 1.5 per cent).

In November 2021, the euro area seasonally-adjusted unemployment rate was 7.2 per cent, down from 7.3 per cent in October 2021 and from 8.1 per cent in November 2020. While continuing to show improvement, current unemployment estimates should continue to be read with caution given that, at least for some market segments, they still may not fully capture the unprecedented labour market situation and resulting supports triggered by the pandemic.

In December, the Governing Council (GC) of the ECB announced a step-by-step reduction in the pace of its asset purchases over the coming quarters. The GC expects to reduce the pace of net asset purchases under the Pandemic Emergency Purchasing Programme (PEPP) in the first quarter of 2022, and net purchases will cease at the end of March 2022. The GC intends to reinvest the principal payments from maturing securities under the PEPP until at least the end of 2024. To maintain flexibility, the GC's mandate facilitates PEPP reinvestments to be adjusted across time, asset classes and jurisdictions in the event of renewed market fragmentation related to the pandemic. Furthermore, net purchases under the PEPP can restart, if warranted, to counter negative shocks related to the pandemic. With respect to the Asset Purchase Programme (APP), the GC decided on a monthly net purchase pace of €40 billion in the second quarter and €30 billion in the third quarter of 2022. From October 2022 onwards, the GC will maintain net asset purchases under the APP at a monthly pace of €20 billion for as long as necessary to reinforce the accommodative impact of its policy rates. The GC expects net purchases to end shortly before it starts raising the key ECB interest rates. The GC also intends to continue reinvesting, in full, the principal payments from maturing securities purchased

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under the APP for an extended period of time past the date when it starts raising the key ECB interest rates and, in any case, for as long as necessary to maintain favourable liquidity conditions and an ample degree of monetary accommodation.

In the United States, real GDP increased by 0.5 per cent quarter-on-quarter in the third quarter of 2021, after a 1.6 per cent increase in the second quarter of 2021. This decrease in growth in the third quarter reflects a resurgence of Covid-19 cases that resulted in new restrictions and delays in the reopening of establishments in some parts of the country. According to the latest OECD projections, released in December 2021, real GDP growth for the US is expected to increase by 5.6 per cent in 2021, with growth falling to 3.7 per cent in 2022 and 2.4 per cent in 2023. Headline inflation in the US rose by 0.5 per cent in December 2021 compared with November 2021 and by 7 per cent compared with December 2020. This represents the largest 12-month increase since the period ending June 1982. Core inflation rose by 0.6 per cent in December 2021 compared with November 2021 and by 5.5 per cent compared with December 2020. According to the latest OECD projections, US headline inflation is expected to rise to 4.8 per cent in 2022 and to fall to 2.5 per cent in 2023. In November, the unemployment rate fell by 0.4 percentage points to 4.2 per cent. While unemployment levels have declined notably over the past year, they remain above the pre-pandemic level of 3.5 per cent in February 2020.

In November 2021, the Federal Reserve's Federal Open Market Committee (FOMC) decided to begin reducing the monthly pace of its net asset purchases by $10 billion for Treasury securities and $5 billion for agency mortgage-backed securities. In December 2021, in light of inflation developments and the further improvement in the labour market, the FOMC decided to reduce the monthly pace of its net asset purchases further, by $20 billion for Treasury securities and $10 billion for agency mortgage-backed securities. Beginning in January 2022, it will increase its holdings of Treasury securities by at least $40 billion per month and of agency mortgage-backed securities by at least $20 billion per month. The Committee held interest rates in a range of 0 to 0.25 per cent.

In the United Kingdom, GDP is estimated to have increased by 1.1 per cent in the third quarter of 2021. The level of GDP in the UK is now 1.5 per cent below where it was prior to the coronavirus pandemic at the end of 2019. According to the latest OECD projections, released in December 2021, real GDP growth for the UK is projected to rise by 6.9 per cent in 2021, with growth moderating to 4.7 per cent in 2022 and 2.1 per cent in 2023. Headline inflation in the UK increased by 0.7 per cent in November 2021, compared with October 2021 and by 5.1 per cent compared with November 2020. OECD projections estimate UK headline inflation is expected to rise to 4.4 per cent in 2022 and to fall to 2.4 per cent in 2023. At its December meeting, the Bank of England's Monetary Policy Committee (MPC) voted by a majority of 8-1 to increase the Bank Rate

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by 0.15 percentage points to 0.25 per cent. The MPC voted to maintain the target for the stock of UK government bond purchases at £875 billion and so the total target stock of asset purchases at £895 billion.

Table 1: Growth and inflation forecasts

	Real GDP Growth			Headline Inflation		
	2021	2022	2023	2021	2022	2023
Euro area	5.1	4.2	2.9	2.6	3.2	1.8
United States	5.6	3.7	2.4	4.6	4.8	2.5
United Kingdom	6.9	4.7	2.1	2.4	4.4	2.4

Source: ECB and OECD

Recent Developments

The domestic economy rebounded strongly in 2021, particularly in the second quarter, despite a slowdown in global trade and higher inflation. Modified Domestic Demand grew by 15.6 per cent year on year in Q2 before growth eased back to 5.3 per cent in Q3. Modified Domestic Demand grew by 8.1 percent on a quarterly basis driven by increased personal and government consumption (Figure 3). As most restrictions eased in 2021 Q3, consumption grew by 6.6 per cent quarterly (7.7 per cent annually), nearing pre-pandemic (2019 Q3) levels. As government expenditure on pandemic supports reduced, and modified investment plateaued, personal consumption contributed most to the growth of domestic demand in Q3 2021.

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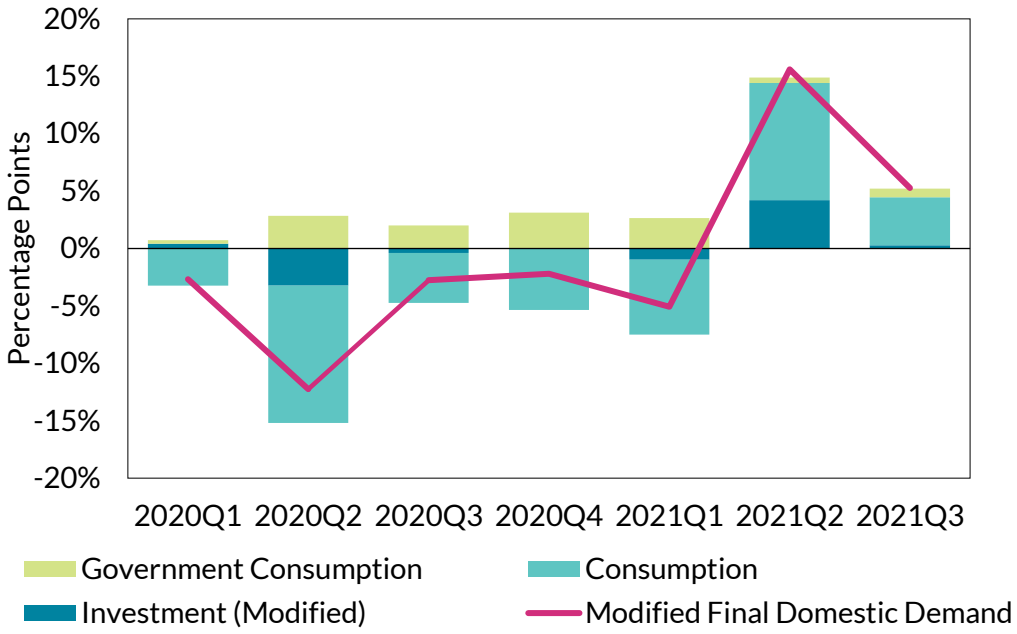
Consumption has been the main driver of the recovery in demand

Figure 3: Contributions to Growth in Modified Final Domestic Demand



Source: CSO and Central Bank of Ireland

All sectors of the economy excluding construction and ICT expanded in Q3 2021 relative to Q3 2020. Distribution, transport, hotels and restaurants increased by 8 per cent on an annual basis. The Arts and Entertainment sector continued to see high growth rates of 22 per cent year on year in Q3. As in previous quarters, industry excluding construction, which is dominated by foreign-owned corporations and represents over one-third of GDP, was not only largely unaffected by the restrictions but grew at a stronger rate than the overall economy in the third quarter (Figure 4 and Figure 5).

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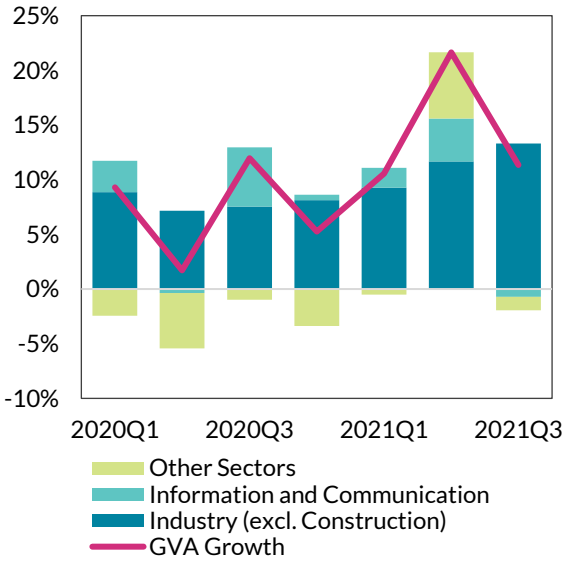
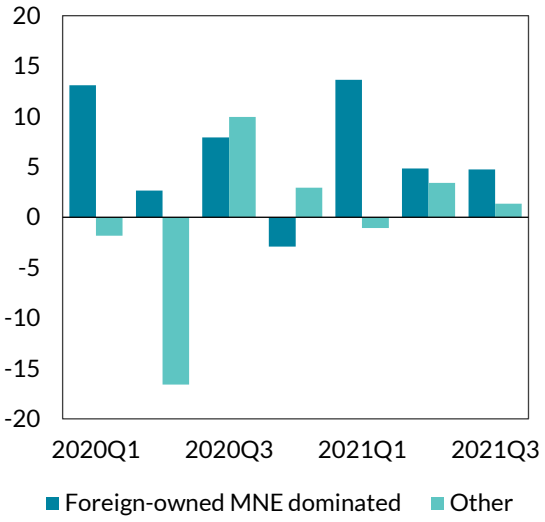
The foreign-owned MNE sector did not see a decline during the pandemic, and has continued to grow strongly throughout

Figure 4: Contributions to GVA Growth



Source: CSO

Figure 5: GVA Growth in MNEs and Domestic Sectors

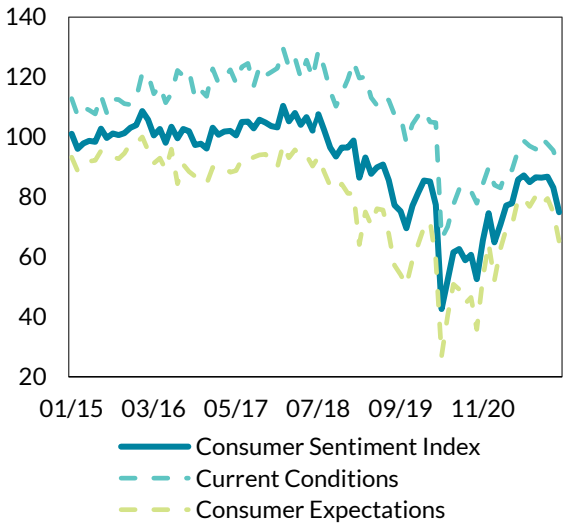


Source: CSO

Consumers remained cautious as new restrictions took hold. The KBC consumer sentiment index registered a level of 74.9 in December, lower than what had been recorded for the second half of 2021 up to that point. Uncertainty surrounding the Omicron variant, fresh restrictions and cost of living concerns dampened sentiment to levels below that recorded in the months preceding the onset of the pandemic (Figure 6).

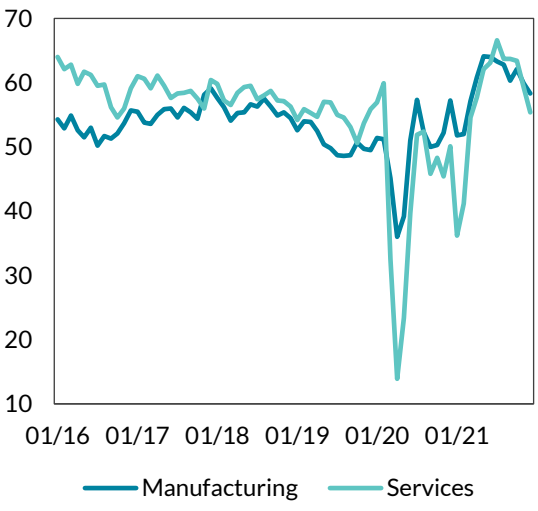
Consumer and business sentiment recovered throughout 2021

Figure 6: Consumer Sentiment Index



Source: KBC Bank Ireland

Figure 7: Purchasing Managers Indices



Source: Allied Irish Banks

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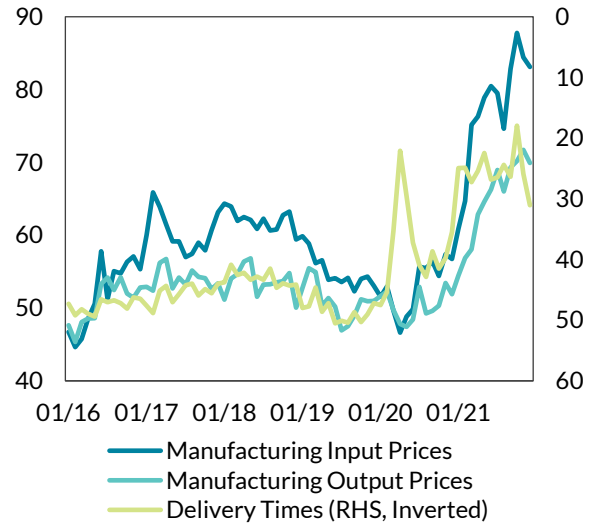
Purchasing Managers' Indices, while at lower levels than in recent months, show continuing signs of growth in manufacturing and services activity. The manufacturing PMI for December stood at 58.3, down from November's figure of 59.9, indicating continued growth but at a somewhat slower pace. A lower pace of growth is noted in the services index, which stood at 55.4 in December, compared to 59.3 in November and 63.4 in October (Figure 7). Supply-chain bottlenecks and pressures continue to increase as delivery times of goods remain uncertain. Firms are also facing continued pricing pressures that are in part being passed through to their customers (Figure 8).

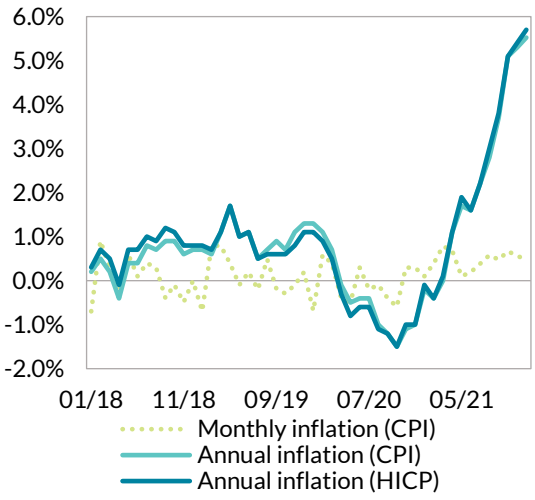
Supply chain disruption led to increased input prices for firms during 2021, one factor behind the strong acceleration in inflation during the year

Figure 8: PMI Input and Output Prices and Delivery Times



Source: Allied Irish Banks

Figure 9: Consumer Price Inflation



Source: CSO

As a result of pent-up pandemic demand, higher energy costs and supply bottlenecks in key sectors, inflation has increased strongly in recent months, reaching 5.7 per cent (HICP) in the year to December (Figure 9). Transport, Housing and Energy have been the main drivers of the rise in inflation. An increase in inflation has nevertheless been registered across most parts of the consumption basket. The current high rates of consumer price inflation are expected to ease later in 2022, as supply chain issues unwind and energy prices stabilise. Wage pressures may increase in certain sectors as the labour market continues to tighten.

With the gradual reopening of the economy and subsequent reintroduction of restrictions, the number of Pandemic Unemployment Payment (PUP) recipients decreased in November before gradually

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increasing again. Some 55,000 persons were registered on the PUP at the end of November, before new restrictions were introduced in December. This figure was down from over 100,000 in early October, following a tapering of rates and a further transition of full-time students off the scheme. Latest data for January show a rise in the number of PUP recipients to 80,000, with the largest increases recorded in contact-intensive sectors. Over 278,000 were registered for the Employment Wage Subsidy Scheme (EWSS) as per December's figures. The seasonally adjusted unemployment rate declined marginally to 5.1 per cent in the month of December.

Exchequer tax revenue amounted to €68.4bn in 2021, a record high and up 19.7 per cent year on year. A lower than expected Exchequer deficit of €7.4bn was recorded for the year.[2] In Budget 2022, the Department of Finance expected the 2021 General Government budget deficit to be €13.3bn, but the figure is now expected to be closer to €9bn. This improvement is due to higher than expected Exchequer tax revenue and lower than expected spending. Gross voted current expenditure increased by 2.6 per cent YoY to €77.6bn while capital expenditure also increased by 3.1 per cent YoY to €9.9bn. VAT and corporation tax earned near identical revenue, each earning over €15.4bn and €15.3bn respectively jointly accounting for almost 45 per cent of Exchequer tax revenue.

The Central Bank's Business Cycle Indicator shows that the economy continues to recover, with a tighter labour market and a positive outlook apparent. The improvement in the BCI since April 2021 has been broad-based with positive contributions from consumer spending, the labour market and industrial production in the indigenous sector. Despite weaker consumer sentiment, the pace of expansion picked up towards the end of the year and activity continues to grow at a rate above its long-run average (Figure 10).

[2] The Exchequer deficit only includes Central Government revenue/expenditure. It is monitored on a monthly basis so can give a timely indicator of eventual outturns in the main Government aggregate – the General Government Balance.

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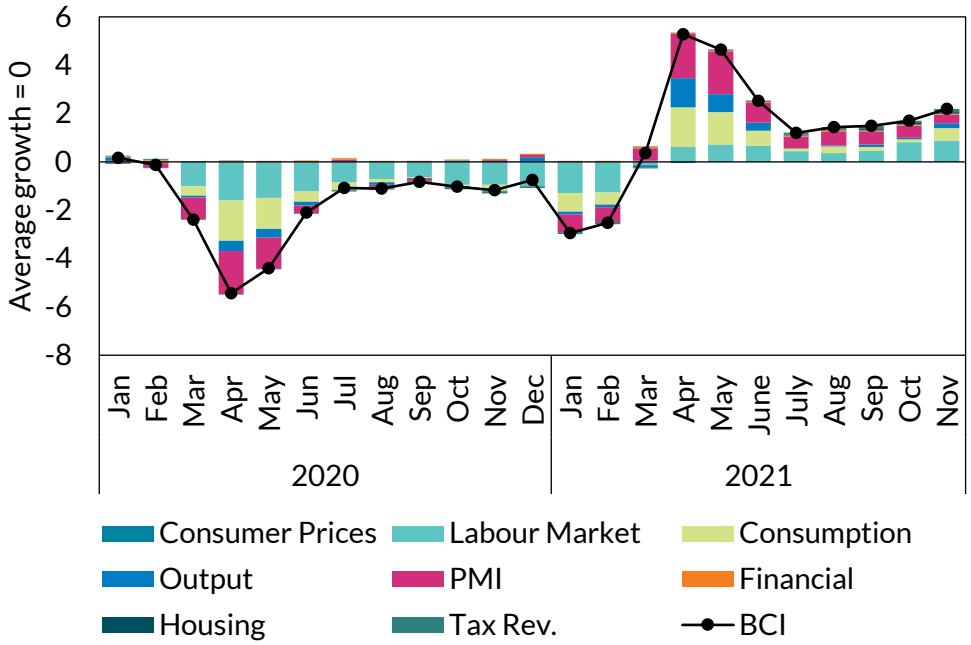
The Business Cycle Indicator points towards strong growth in Q4 2021

Figure 10: Business Cycle Indicator



Source: Author's calculations. Updated 13/01/2022.

Box B: Spending, credit, and deposits: An update on Irish household and business activity

By Statistics Division

This Box provides an update on Irish households' and firms' financing activities, focusing on recent data developments. Consumer activity picked up strongly in the lead up to Christmas with a significant decline in household deposits and increase in card spending. The stock of deposits remains at high levels following the strong build up during the early pandemic period. Meanwhile, mortgage lending activity has shown tentative signs of recovery from the early pandemic period with SME and consumer lending continuing to lag pre-pandemic levels.

Household Spending

High frequency data show that card spending (including ATM withdrawals) remains strong in late-2021 and into early 2022. Spending in November was particularly high relative to 2020, due to a looser health restrictions and higher levels of consumer confidence leading up to the Christmas period. Early data for December show more modest increases but a strong second half of the month resulted in card spending up 8 per cent year-on-year over the month. The primary drivers of the increase was increased spending in service sectors such as accommodation, dining, and transport.

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Although January is typically associated with lower consumer spending, year-on-year comparisons indicate that people were more actively spending in the service sectors than in the heavily restricted 2020/21 post-Christmas period.

Figure 1: Strong levels of consumer card spending

Chart: Year-on-year change in card spending and cash withdrawals (daily data)

Source: Central Bank of Ireland

High-frequency data illustrate the immediate and sustained rise in accommodation and restaurants spending as service elements of the economy reopened in summer 2021 (Figure 2), with restaurant and dining recording strong activity December. The increased level of in-person spending is reflected in a higher share of in-store and ATM card activity, especially around the Christmas period. Spending in the accommodation sector peaked in early August before moderating at the start of the new academic year. The accommodation and dining spending spiked again during school mid-terms reflecting some normalisation spending and lifestyle patterns. Meanwhile, transport spending continued to increase into Autumn, while spending on groceries remained steady throughout the year, with a normal peak leading up to Christmas day. Nonetheless, the grocery spend remains significantly higher than pre-pandemic levels.

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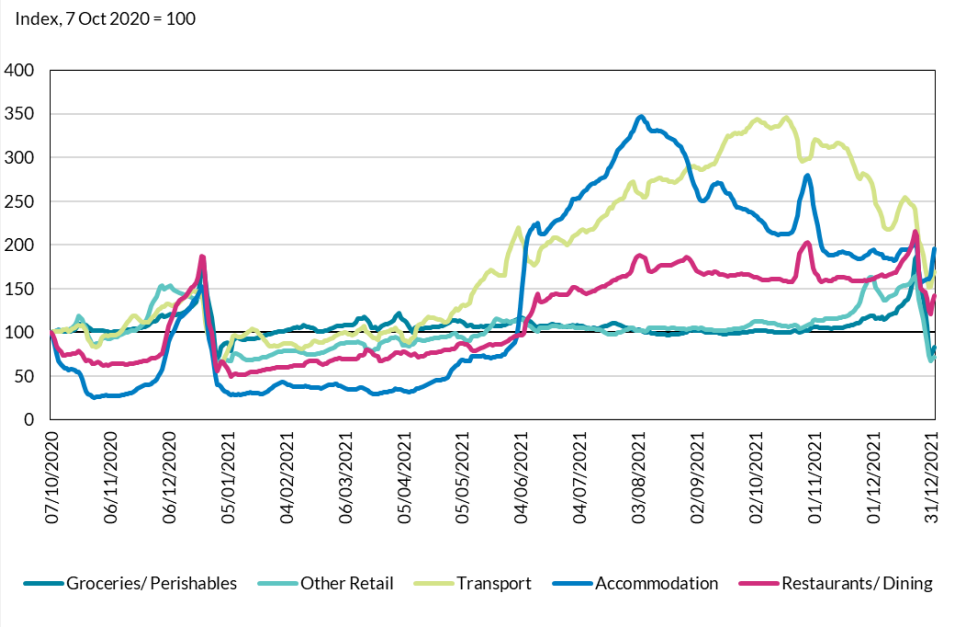
Figure 2: Spending in service sectors increased as restrictions were eased

Chart: Daily sectoral card spending by spending type



Source: Central Bank of Ireland

Household deposits and lending

Aggregated household savings have risen sharply since the beginning of the Covid-19 pandemic and the introduction of the associated public health measures. In line with the increased consumer spending, the latest Credit and Banking Statistics indicate a sharp decline in deposits in November of €1.4 billion. This is the first month since the start of the pandemic where households have withdrawn a significant amount from deposits. Nonetheless, the stock of household deposits is still €22 billion the start of the pandemic reflecting the scale of the savings accumulated. The annual rate of growth has moderated further to 8.8 percent, slowing from its pandemic high of 14 per cent in early-2021 (Figure 3).

This marked rise in household deposits has translated into higher household financial assets, which was the primary driver, along with rising housing assets and a slight reduction in household liabilities, of an increase in overall household net worth. The latest data from the Quarterly Financial Accounts for Q2 2021 shows household net worth at a new series high of €935 billion (Figure 4), or 13 per cent higher than prior to the beginning of the pandemic (end-2019).

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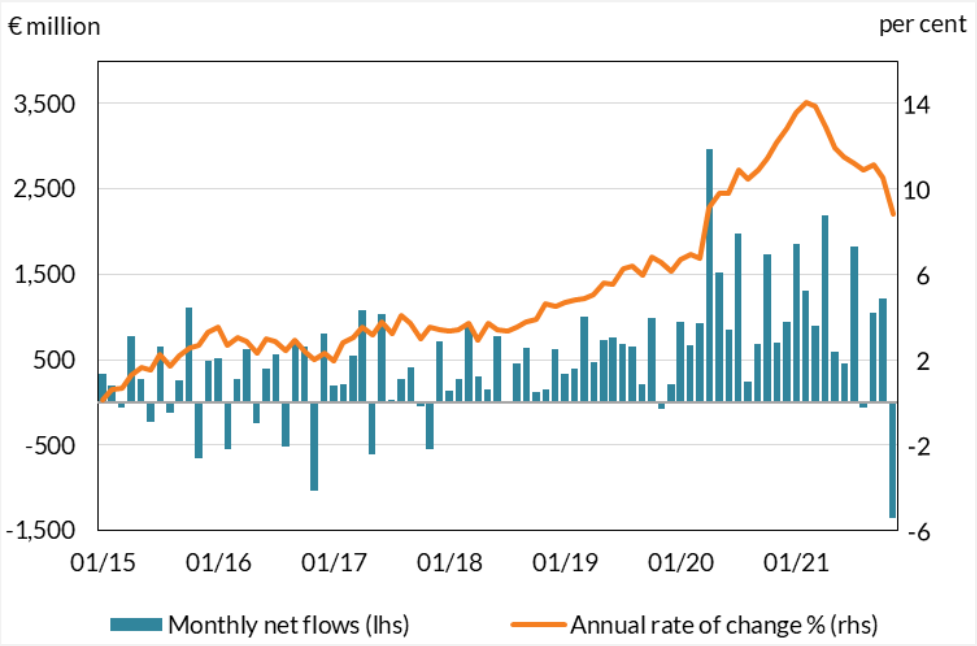
Figure 3: Annual rate of deposit growth has moderated, but remains high

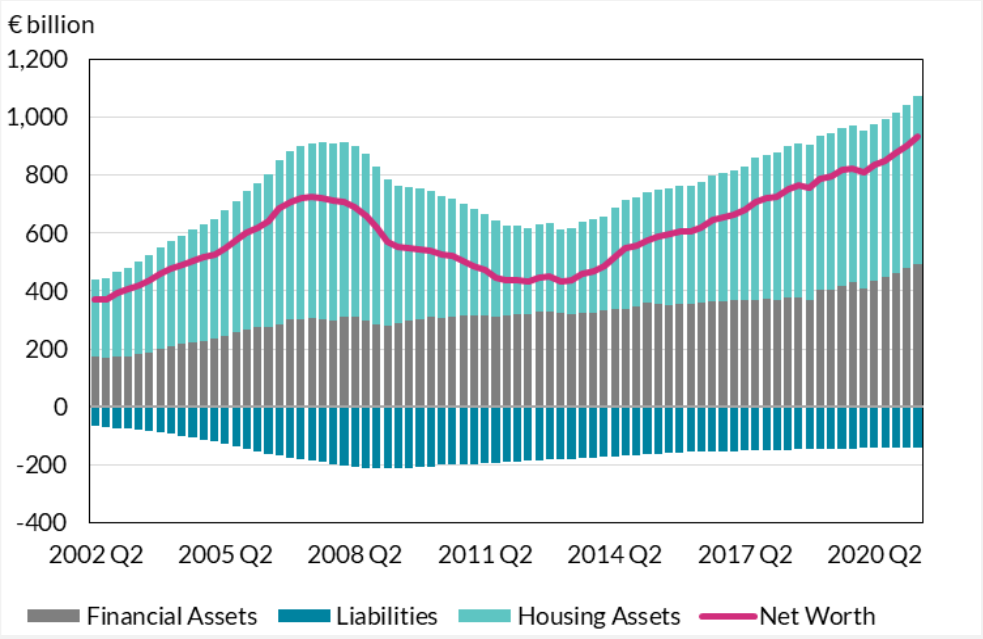
Chart: Deposits from Households; net flows, and annual rate of change



Source: Central Bank of Ireland

Figure 4: Household net worth has risen to a new high

Chart: Household Net Worth



Source: Central Bank of Ireland

The level of household lending has recovered from the lows seen in 2020, driven by a recovery in the level of mortgage lending. The volume of new mortgage agreements in recent months is in line with seasonal pre-pandemic volumes (Figure 5). However, the

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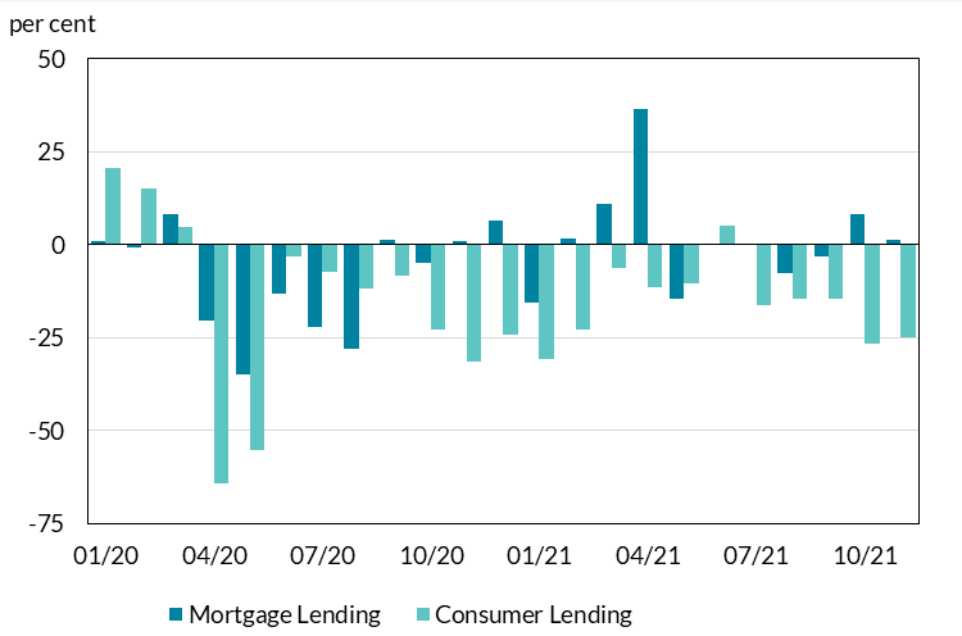
recovery in consumer lending has not materialised. This contrasts with the increased consumer spending activity, but indicates that households may, in part, be using accumulated savings in place of consumer loans (e.g. cars, education, and travel).

Figure 5: Mortgage lending is recovering to pre-pandemic norms but consumer lending lags

Chart: New Lending to Households by Purpose (percentage change on same month 2019)



Source: Central Bank of Ireland

Forward indicators on mortgage activity remain strong with new credit enquiries in the Central Credit Register (CCR) and mortgage approvals data remaining robust. The first-time buyer segment was particularly strong with mover purchasers also increasingly active (Figure 6). Mortgage top-ups, often used to fund consumption or home improvements, remain weaker in line with overall lower consumer lending activity.

New mortgage lending (ex. renegotiations) data show that the pick-up observed at the beginning of the second quarter has stabilised in recent months with similar level of activity compared with late 2020. Despite this increase, the decline in the number of properties available for purchase, and hence new sale completions, is likely constraining the volume of new mortgage lending. According to the latest Bank Lending Survey published in October, it is expected that demand for house purchase loans will weaken marginally, but this is in part due to some reporting Banks observing changes in borrower applications due to announced withdrawals from the market. Banks also noted that there may also be upward pressure on demand as consumer confidence increases.

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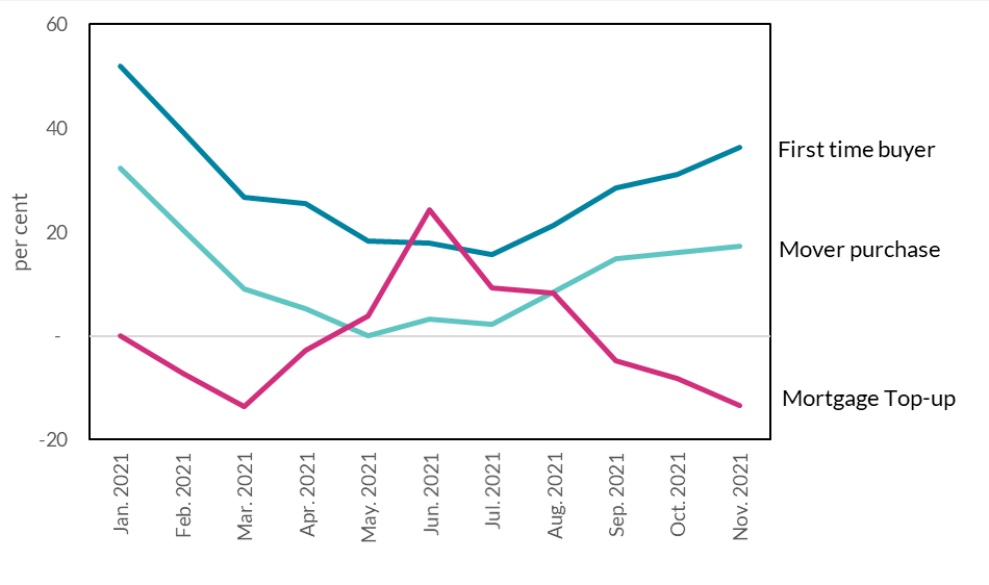
Figure 6: Mortgage approvals strong relative to pre-pandemic period

Chart: Mortgage approvals change on same period 2019



Source: BPFI

Business Credit and Deposits

Net lending to businesses so far this year has been positive, if somewhat subdued (Figure 7). This contrasts with 2020, when companies deleveraged with repayments significantly outpacing drawdowns of new credit. In the first eleven months of 2021, drawdowns exceeded repayments by €156 million, compared to net repayments of €1,344 million in the same period of 2020.

The relatively muted credit picture can also be seen in gross new lending to small and medium sized enterprises (SMEs). The latest data for the third quarter show new loans down 1.3 per cent on the same period in 2020. Overall, gross new lending to SMEs in the first 9-months was €2.9bn which is 22 per cent below the same period in 2019. The recovery in SME lending has been uneven across sectors of the economic sectors. Service-based sectors such as Hotels and Restaurants continue to see very low new loans drawdowns reflecting the uncertain operating environment and outlook. Overall, new lending to this sector was 69 per cent lower in the first three quarters of 2021 than in same period in pre-pandemic 2019. Lending activity remains stronger in other areas of the economy such as business services and manufacturing. Lending in the construction and real estate sectors, which saw some of the largest nominal declines at the beginning of the pandemic, has only partially recovered with lending in the first nine months of 2021 still 31 per cent below the same period in 2019. The Bank Lending Survey points towards a modest increase in demand, driven by SMEs, but we can expect significant variations across economic sectors until business outlook stabilises.

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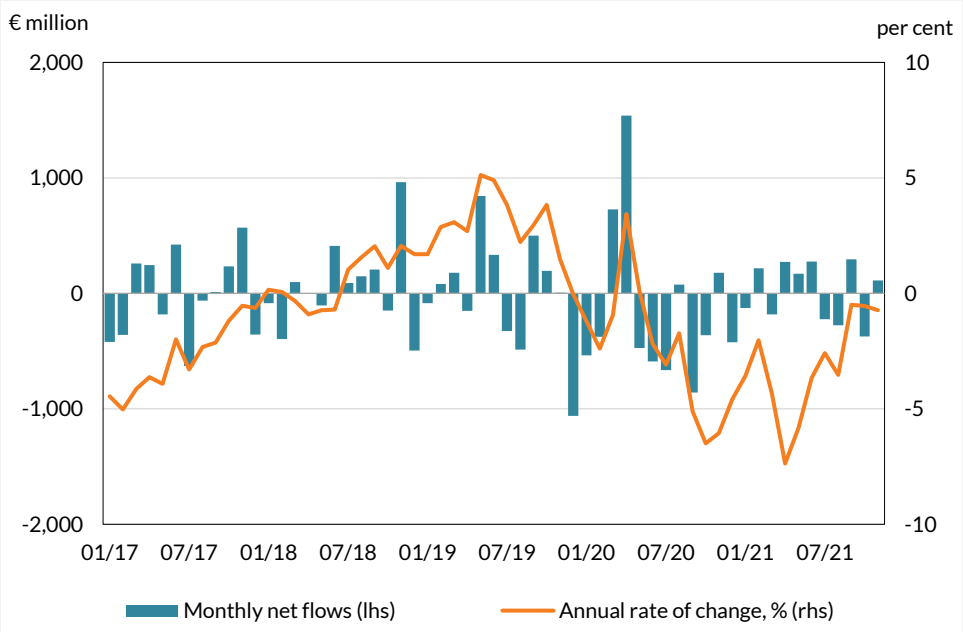
Figure 7: Outstanding loans to non-financial companies stabilises

Chart: Net flows of loans to Non-Financial Corporations



Source: Central Bank of Ireland

Following a similar trend as seen with households, the rate of deposit accumulation by businesses has slowed throughout 2021 relative to the rapid accumulation of saving observed during the height of the pandemic. The annual rate of increase fell to 10.7 per cent in December, the lowest rate of increase since summer 2019. Cumulative net inflows of deposits in the period since January amounted to €6.6 billion, compared to €10.3 billion for the same period in 2020.

Box C: The Impact of the Omicron Variant of Covid-19 on the Irish Economy

***By Stephen Byrne*[3]**

In late November, a new variant of SARS-CoV-2, designated Omicron - was identified by public health officials. From an epidemiological point of view, Omicron is more transmissible and there is evidence that existing vaccines are less effective in preventing infection from this variant compared with Delta and earlier variants.[4] Since the emergence of Omicron in Ireland, the number of recorded daily infections rose to an average of

[3] Irish Economic Analysis Division
[4] https://www.who.int/news/item/28-11-2021-update-on-omicron

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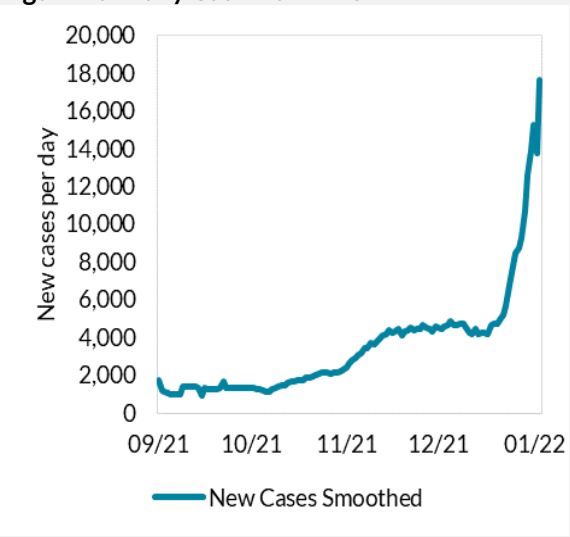
20,000 per day in early January, although constraints on testing capacity mean that this figure was most likely higher. [5]

High daily infections s saw a shift to home working, but had a smaller impact on mobility in retail settings

Figure 1a: Daily Case Numbers



Source: HSE

Figure 1b: Mobility

Source: Google Mobility

Despite the number of cases, this wave of the Covid-19 pandemic is likely to have a smaller impact on the Irish economy than previous waves in March 2020 or January 2021 for a number of reasons. First, more than 90 per cent of the adult population has received two vaccine doses, and throughout December and January a growing proportion have received a third dose. Moreover, emerging evidence suggests that Omicron is less likely to cause severe illness than other variants. Combined, these factors have reduced the proportion of Covid cases that require treatment in hospital. This has allowed fewer and less stringent restrictions on economic activity to be imposed to date during this wave despite the record number of cases (Figure 2). In December and January, public health measures were largely confined to the hospitality and entertainment sectors, and the measures reduced capacity and opening hours rather than blanket closures seen during previous waves.

[5] 14 Day Epidemiological Report – Health Protection Surveillance Centre

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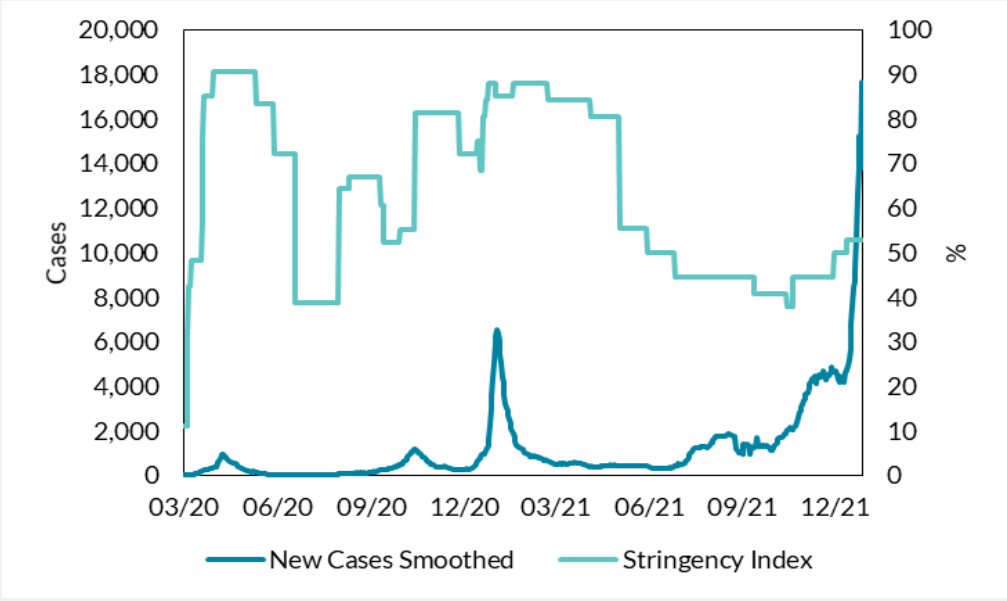
Cases are resulting in less stringent restrictions owing to vaccinations and adaptation

Figure 2: Cases and Stringency



Source: HSE and Oxford Blavatnik School of Government
Note: Stringency Index measures the level of public health restrictions in place on a harmonised Basis for cross-country comparison. Case numbers are a 7-day moving average.

Secondly, the effect of an increase in cases or a tightening of restrictions on employment and output is now smaller than during previous waves of the pandemic. Households and firms have invested and learned to adapt quickly to a surge in cases. Those who can work from home have been able to switch easily, as the infrastructure and processes were acquired and developed during earlier waves. Retailers, who made significant investments in e-commerce and delivery logistics during 2020 and 2021, have been able to continue trading despite a decline in footfall. Even in the worst affected contact-intensive services sectors, medical interventions have supported demand by reducing risk. Vaccinations, as well as developments in the use of at-home testing, has allowed demand for hospitality and entertainment services to be higher than during previous waves where these interventions were not available or widely used.

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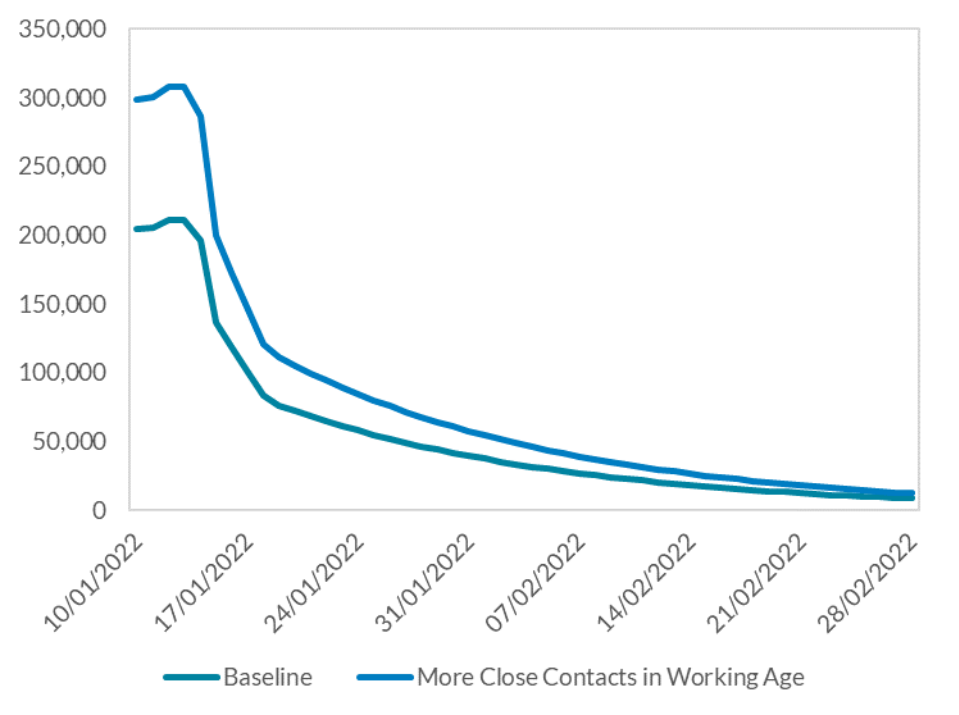
Looking ahead, the expected decline in cases, coupled with an increase in the provision of booster vaccinations, will reduce the number out of work owing to isolation

Figure 3: Estimated number of people unable to work due to Covid-19



Source: HSPC and Authors Calculations

However, while the economic impact of Omicron is smaller, there are still some effects arising from such a significant level of the virus in the community. Most critically, in late December and early January there were significant numbers of workers across all sectors isolating or restricting their movements (not leaving home) either due to infection or because they were designated close contacts of confirmed cases. In the first weeks of January, approximately 140,000 cases per week were notified to the public health authorities. It is estimated that between 140,000 and 300,000 people may have been physically out of work as a direct result of self-isolation on a given day in those weeks. This was significantly mitigated by eliminating the requirement to isolate for close contacts who have received their booster vaccination. Our estimate, informed by data from the HPSC and the CSO, assumes that each case has 3.4 close contacts, that 15 per cent of those isolating because they have tested positive for Covid are too sick to work, and that 46 per cent of the remaining working population that are isolating can work from home. Figure 3 shows the significant effect of the changes in the guideline for close contacts and the shortening of the isolation times for confirmed cases. These

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assumptions do not take account of the indirect effects of self-isolation.[6] Throughout the economy, there are also likely to be thresholds over which certain firms are unable to operate if a given number of staff are absent. Consumer and business sentiment is also likely to be negatively affected by the upsurge in virus infection with some early evidence of this from survey data.[7] This could adversely affect consumption and investment spending during Q1 2022, part of which will then take place in subsequent quarters.

Table 1: Scenario estimates - numbers physically out of work in late December/ early January as a result of isolation/restricting movements

	Cases Per Week (thousands)	Isolating (thousands)	Employed Isolating (thousands)	Out of Work (thousands)
Baseline	136	598.4	295	168.7
Higher cases	200	880	433.9	248.1
More close contacts[1]	136	680	335.3	190.4
Fewer close contacts[2]	136	544	268.2	154.2
Close contacts more likely to be working age[3]	136	598.4	430.8	242
Higher cases and close contacts more likely to be of working age	200	880	633.6	355.9

Source: CSO, HSPC, HSE, and Authors Calculations
Notes: 1) Assume each case has 4 close contacts, compared with the baseline assumption of 3.4.
2) Assume each case has 3 close contacts.
3) The baseline assumes that the isolating are distributed evenly across the population, i.e. 49 per cent of the population is employed and therefore 49 per cent of the isolating are employed. This row assumes those isolating mirror the percentage of Covid cases that are in the working age population (72%).

Using estimates of output per hour worked, the levels of absenteeism in early January (before the change in guidelines) would result in annual GNI* being between 0.1 and 0.3 per cent lower relative to a situation of no isolation requirements for each week such requirements are in place, depending on the scenario and the number of cases.[8] By early February, our estimate would suggest a decline of between 0.02 and 0.06 per cent in GNI* per week, gradually diminishing thereafter (based on current trends). In some sectors, part of any lost output in a given week would likely be pushed into a subsequent period, implying the net effect on GNI* over the course of the year would likely be even lower than these estimates.

[6] An example of indirect effects would be if childcare providers were unable to offer their service due to employees being absent, this in turn could limit the ability of working parents attending their own place of work.
[7] See https://www.kbc.ie/w/december-drop-consumer-confidence-points-to-seasonal-fear?redirect=%2Fblog%2Fconsumer-sentiment-surveys
[8] OECD estimates of output per hour worked

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Omicron will also affect the Irish economy through the global impact of the surge in the disease and its effect on supply chains and external demand. The pandemic has restricted labour supply internationally and there have been increases in the price of intermediate inputs used in the production process. These developments have contributed to increases in consumer price inflation. While this inflation is expected to be start to decline in the second half of 2022, the emergence of the omicron variant will cause these labour market and supply chain effects to persist for longer that might have been expected in the absence of the recent upsurge in the virus. Furthermore, the longer the inflation persists the greater the risk of second round effects, which may prove longer lasting.[9]

Looking ahead, our baseline macroeconomic projection assumes that future possible waves of the Covid-19 pandemic in 2022 and 2023 will have a diminishing economic impact compared with previous waves as households and firms continue to adapt, and as medical interventions become more sophisticated. As a result, the domestic economy, which has likely surpassed its pre-pandemic size by end-2021, is expected to converge on its potential over the course of our forecast horizon. However, demand in contact-intensive sectors such as hospitality and tourism is likely to remain below pre-Covid levels until at least 2023. Were a new variant of Covid-19 more severe and/or resistant to existing vaccines and treatments to emerge, then more negative economic outcomes than projected in our baseline forecasts would arise.

Demand

Overview

The Irish economy is recovering from the effects of the pandemic. By the end of 2021, it is estimated that Modified Domestic Demand had surpassed its pre-pandemic level. Consumption grew by 19.3 per cent year on year in the second quarter of 2021 and by 7.7 per cent year on year in the third quarter. Despite a surge in Covid-19 cases in the fourth quarter, data on retail sales and spending on payment cards point to continued consumption growth to the end of the year (Figure 13 and 14).

The emergence of the Omicron variant of Covid-19 has increased uncertainty about the duration of the pandemic, but indications thus far suggest that its impact on economic activity will be smaller than previous variants. The forecasts in this *Bulletin* assume that while further waves of

[9] Byrne, D and Zivile Zekaite. An Overview of Inflation Developments. Central Bank of Ireland Economic Letters. 2021(7)

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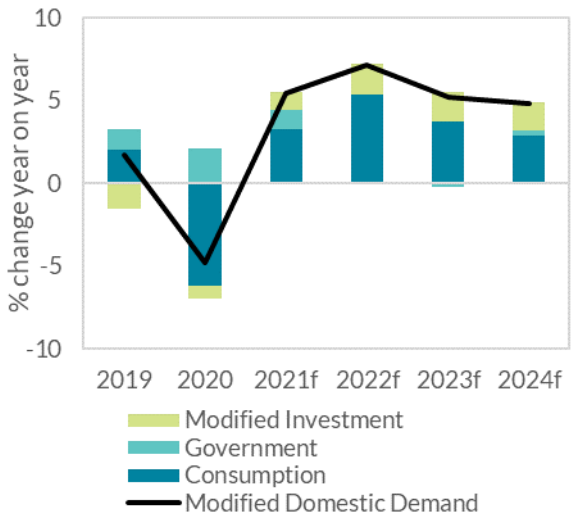
the virus may arise during the projection horizon, the economic effects will continue to diminish over time as households and firms adapt to living with the virus and medical interventions continue to develop (See Box C). Accommodative fiscal and monetary policy will support strong consumption and investment growth this year and next.

The strong recovery, which began in the second half of 2021, is expected to continue to gather pace during the first half of 2022 before slowing down in the latter half of the year into 2023 and 2024. Modified Domestic Demand is forecast to grow by 7.1 per cent this year, 5.2 per cent in 2023 and 4.8 per cent in 2024 (Figure 11).

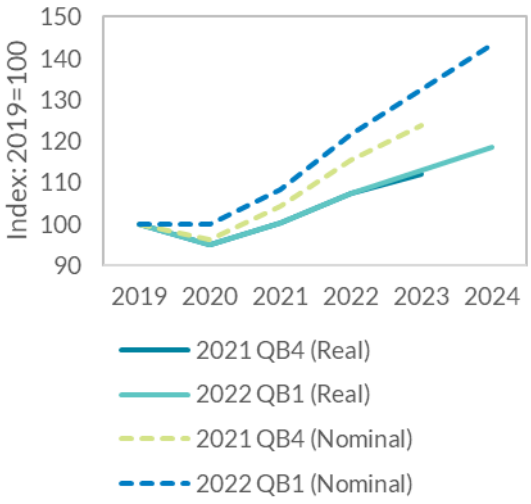
Consumption will be the primary driver of the recovery in domestic demand in the near-term, but investment picks up strongly in 2023 and 2024

Figure 11: Contributions to Modified Domestic Demand



Source: CSO and Central Bank of Ireland

Figure 12: Revisions to Real and Nominal MDD



Source: CSO and Central Bank of Ireland

Consumption

Private consumption will remain the key driver of growth in domestic economic activity between 2022 and 2024. Consumption will benefit from a rebound in disposable income, a robust labour market and the use of savings accumulated during the pandemic. However, higher inflation and supply bottlenecks for some, predominantly imported goods during 2022 will limit consumption growth. As these headwinds dissipate, consumption is forecast to respond more strongly in the second half of the year than expected at the time of the last Bulletin, leading to an upward revision to the 2022 consumption forecast. Consumption is forecast to

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grow by 9.4 per cent this year and by 6.5 per cent and 4.9 per cent in 2023 and 2024, respectively.

In the near term, the pandemic will mean that consumption will recover more slowly in sectors like hospitality and tourism. However, monthly card payment data suggest that services spending is now above its pre-pandemic level (Figure 13). Retail sales data suggest that during periods where Covid-19 case numbers are high, spending declines in sectors such as tourism and contact-intensive settings, for example bars and restaurants (Figure 14). This occurs even in the absence of restrictions. Accordingly, these sectors may take longer to recover.

Monthly card payment and retail sales data show the recovery in retail spending caught up with services spending

Figure 13: Monthly Card Payment Data

Source: Central Bank of Ireland

Figure 14: Retail Sales (excluding motor trades)

Source: CSO

Consumption growth will bring the savings ratio below pre-pandemic levels in 2023 (Figure 15). Consumption fell sharply during 2020 and early 2021, but the combined fiscal interventions and wage subsidies ensured that incomes continued to grow (Figure 16). This meant that households, on average, saved more of their income than during normal times. As the pandemic persists and these savings remain on household balance sheets for longer, they are more likely to be treated as financial wealth and, accordingly, less likely to be spent in the short-term. However, the recovery in consumption towards its trend, as well as higher consumer price inflation, will gradually bring the savings ratio just below 8 per cent in 2024. A portion of this new financial wealth will likely also feed through to

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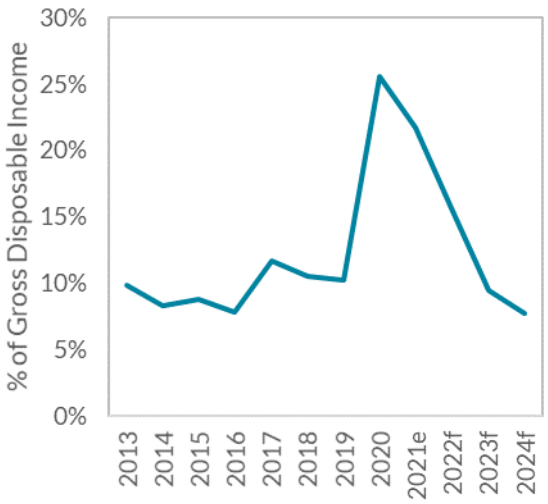
holdings of non-deposit financial assets and investment in housing (including home improvement) or other physical assets.

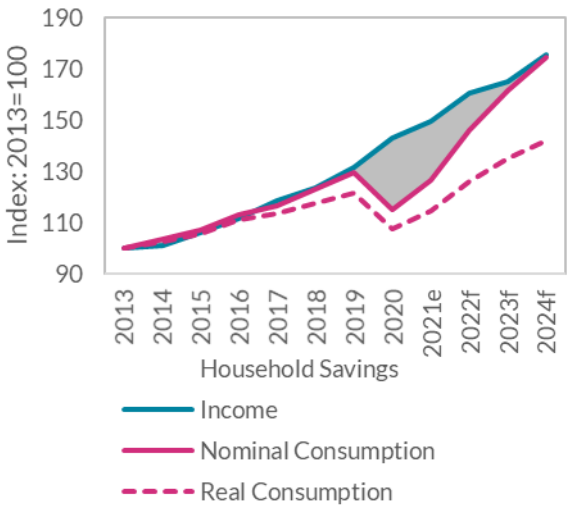
The savings ratio will fall below the pre-pandemic level in 2023, driven by a pickup in nominal consumption

Figure 15:



Source: CSO and Central Bank of Ireland

Figure 16:



Source: CSO and Central Bank of Ireland

Investment

The continued recovery in construction will spur strong growth in modified investment (Figure 17). There were approximately 21,000 new residential units completed in 2021. Looking ahead, commencements, which are a leading indicator for new completions of residential units over the coming 12 months, point to a continued increase in 2022 (Figure 19). However, while commencements were running at approximately 30,500 annually in December 2021, pandemic-related labour and materials shortages mean that not all of these units are likely to be finished in 2022. Our current forecasts for housing are for approximately 25,000 units in 2022, followed by 30,000 and 35,000 units in 2023 and 2024, respectively.

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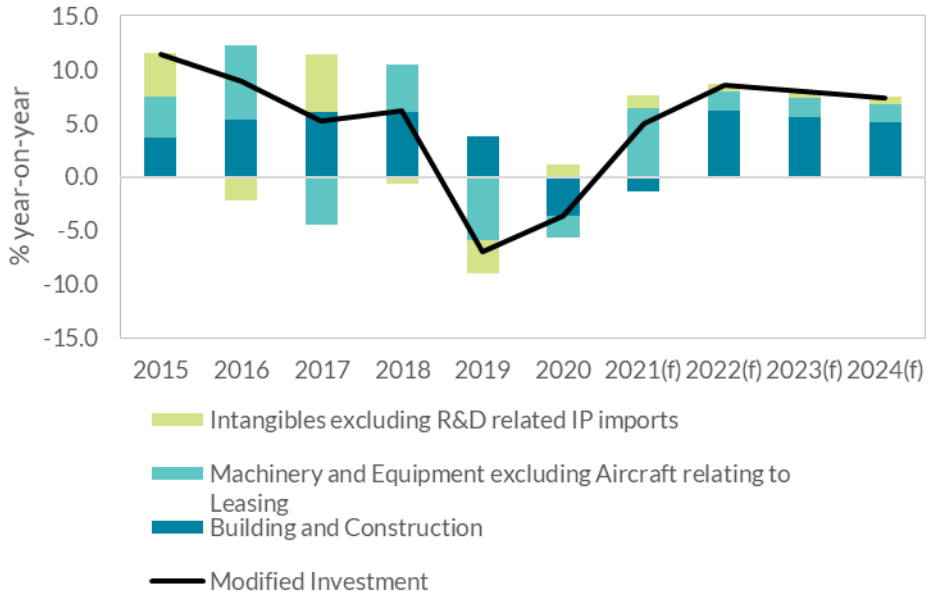
Building and Construction is forecast to grow by around 18 per cent, and will be the main factor behind strong modified investment growth

Figure 17: Contributions to Modified Investment



Source: CSO and Central Bank of Ireland

With substantial increases in both public and private outlays on housing expected in the years ahead, capacity constraints and other factors could limit the extent to which increased expenditure translates into more housing units. Rising expenditure on building and construction in general could see increases in nominal expenditure outpace gains in real expenditure, with more expenditure absorbed by higher costs. A rise in labour resources and an easing of supply chain pressures and input costs will have to emerge to maximise the output delivered from increased investment spending. The relative changes in house prices and input costs, and in turn profitability of building projects are important determinants of how quickly new units will be delivered.[10]

Non-residential building and construction was negatively affected by sites closing in early 2021 and public capital expenditure was lower than originally planned. Non-residential investment declined by 10.8 per cent in the first three quarters of 2021, year-on-year. There is some uncertainty surrounding the effect the pandemic may have on longer-term structural changes in firms' demand for office

[10] See R. Lyons and M. Günnewig-Mönert (2022) Housing prices, macro-prudential rules and the elasticity of housing supply: Evidence from Ireland.

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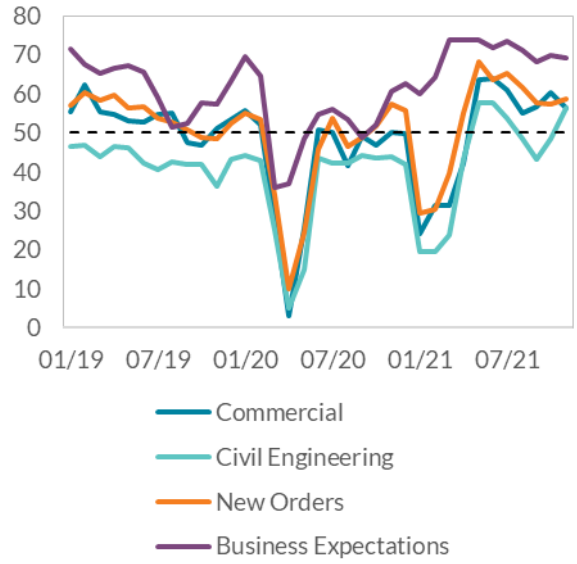
and retail space relating to the reliance on the work-from-home model and the longer-term effects of the pandemic on business restarts and changes in consumption patterns. Nevertheless, the outlook is for non-residential investment to be supported by a substantial increase in government spending as outlined in the National Development Plan. The Construction PMIs for November 2021 point to expansion in all sectors suggesting a more positive 2022 outlook (Figure 18). Non-residential investment is forecast to increase by 8 per cent in 2022 and by 6 per cent in 2023 and 2024.

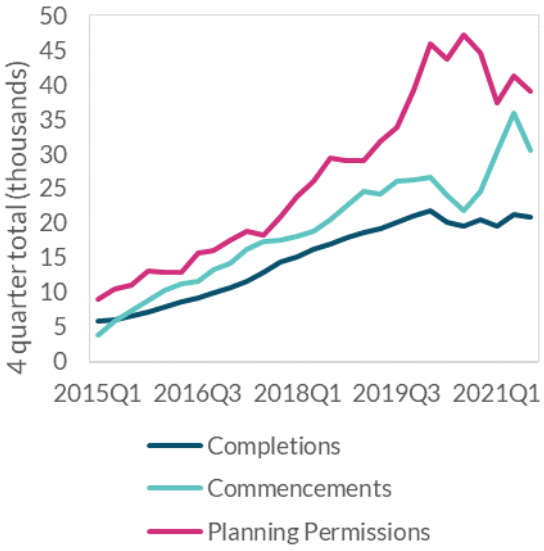
Leading indicators suggest a significant pickup in construction activity in the near term

Figure 18: Construction PMIs



Source: Markit

Figure 19: Residential planning permissions, commencements and completions



Source: CSO

Machinery and equipment investment excluding leasing and aircraft remained buoyant in the first three quarters of 2021, and is forecast to increase by 7 per cent per annum over the forecast horizon. The growth expected in machinery and equipment is in-line with the broader economic conditions and given the higher infrastructure spending and continuing strong growth in business output. Investment in intangibles excluding R&D related imports is forecast to increase by 5 per cent per annum over the forecast horizon.

Growth in modified investment is expected to remain robust, but moderate over the projection horizon, with risks to the investment outlook broadly balanced. Modified investment is forecast to grow by 8.6 per cent this year, moderating slightly to 7.9 per cent and 7.4

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in 2023 and 2024, respectively (Figure 17). While Omicron may add to uncertainty in investment decisions, the relationship between the number of cases and associated public health-related economic restrictions has weakened, and firms' and individuals' ability to adapt to restrictions has increased (see Box B). That being said, supply disruptions and higher input costs may limit the scope for more robust real growth in modified investment.

Exports, Imports and Balance of Payments

Pharmaceuticals and computer services exports continued to grow strongly during 2021, but exports by Irish firms also recovered in line with global demand. Two sectors are now responsible for more than 50 per cent of Irish exports in value terms, namely the pharmaceutical and ICT sectors. A third factor, namely the production of goods abroad on behalf of Irish resident firms, was the main factor behind export growth in the first three quarters of last year. In the National Accounts, these activities are treated as Irish exports, even though the physical goods themselves never cross the Irish border and thus have no meaningful impact on employment or incomes in Ireland.[11] Moreover, almost all of this activity relates to foreign-owned multinational enterprises, so the profits arising from these exports eventually flow out of Ireland to foreign investors. Exports of some more domestically-dominated sectors, such as beverages and tobacco and manufactured items, saw a more moderate recovery in 2021. Other services exports, such as tourism and transport, remain below their pre-Covid levels and are forecast to take longer to recover

The continued recovery in the global economy will support all exporting sectors. The latest forecast of global import demand (weighted by Irish exports to those destinations last year), shows growth of 5.3 per cent in 2022, 4.5 per cent in 2023 and 3.4 per cent in 2024, slightly stronger than was expected at the time of the last *Bulletin*. This is consistent with the IMF and OECD's outlook for growth in advanced economies (see Box A). However, these forecasts are predicated on an unwinding of supply constraints, which have hampered manufacturing and shipping since the onset of the pandemic and, as such, are subject to continued uncertainty since the onset of the Omicron variant. More persistent supply constraints globally may slow the pace of expansion and, accordingly, pose a downside risk to Irish exports.

[11] See Box C, Quarterly Bulletin 4. 2021

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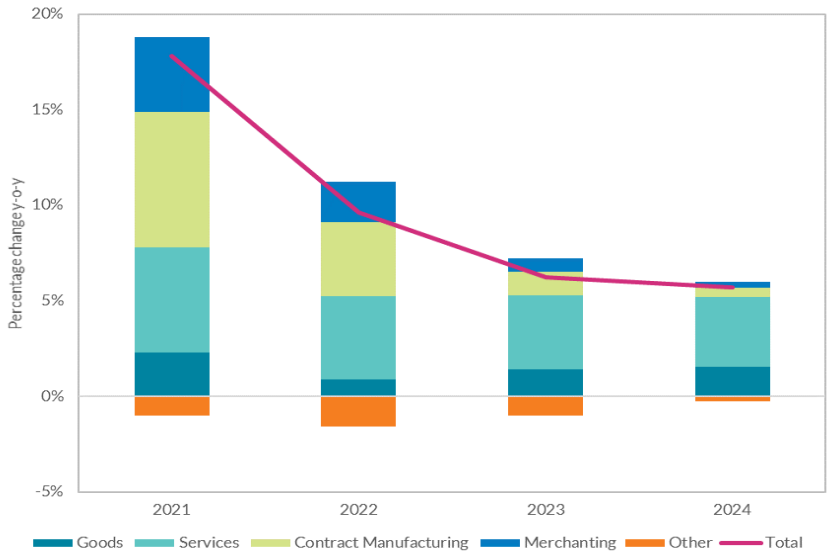
The outlook for Irish exports is favourable, both in headline terms and for indigenous exporters. Exports are forecast to grow by 8.5 per cent in 2022, and by 9 per cent and 5.7 per cent in 2023 and 2024, respectively (Figure 20). The forces that have driven Irish exports to grow strongly over the past 24 to 36 months are expected to continue over the projection horizon. In particular, production in the pharmaceutical sector is likely to continue to grow as new capacity comes on-stream in Ireland. Moreover, intellectual property assets held by IT firms, which were imported in recent years, are forecast to continue to yield growth in computer services exports.

Services will be the primary driver of export growth

Figure 20: Contributions to Export Forecast



Source: Eurostat and Central Bank of Ireland calculations

The UK has again delayed the introduction of post-Brexit checks on Irish exports to the UK. While the UK left the European Union on 31st January 2020, with the subsequent transition period ending on 31st December 2020, it delayed the implementation of border checks and tariffs on goods coming from the EU until 1st January 2022. These checks have now been further delayed in the case of Irish goods going to the UK. This has resulted in an upward revision to the outlook for merchandise exports in 2022 (Figure 21). However, the checks will eventually be implemented and will reduce Irish-UK exports in the Agri-food sector in particular. Imports from the UK declined by 10.5 per cent in the first eleven months of 2021, while overall goods imports have grown strongly, suggesting that Irish firms and consumers have sourced products from alternative destinations.[12] Imports

[12] See Flynn, E., Kren, J., and Martina Lawless (2021) Initial impact of Brexit on Ireland-UK trade flows. ESRI Working Paper.

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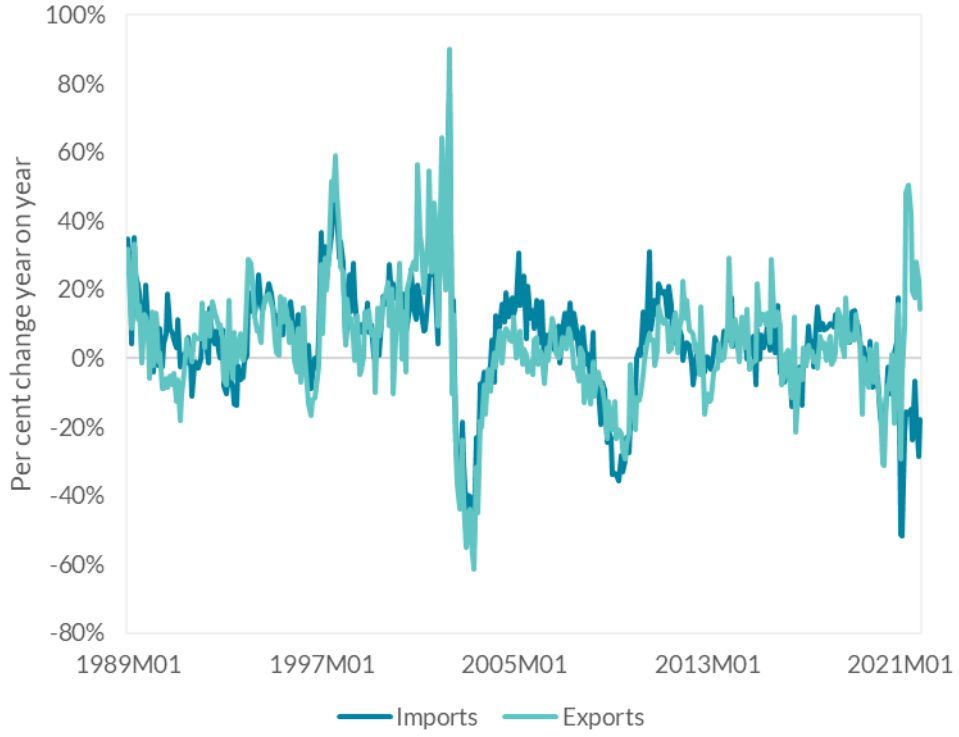
from Northern Ireland increased by 64.3 per cent over the period, whereas those from Great Britain fell by 20.7 per cent. Monthly trade data point to a recovery in imports from GB during the second half of the year but import values up to November 2021 remained below that of the previous year and significantly weaker than the trend in overall imports.

Delayed implementation of post-Brexit border checks has meant Irish exports to the UK have not been as adversely affected as imports from the UK – breaking a long link

Figure 21: Ireland/UK Exports and Imports (Seasonally Adjusted excluding Chemicals and Pharmaceuticals – Current Prices)



Source: Eurostat and Central Bank of Ireland calculations

Imports (excluding intellectual property) are forecast to grow by 8 per cent this year in line with the recovery in consumption and investment. The expected continued growth in economic activity will result in a rise in imports, and it is expected that some of the pandemic-induced move towards online shopping will increase the import content of consumption, at least in the short-term. Imports are forecast to grow by 7 per cent next year and by 4.9 per cent in 2024.

The Irish current account surplus surged to a historical high in 2021Q3, rising to €23.2bn. Strong quarterly growth was observed in both goods and services exports, amid increased global demand and a resurgence in business activity. The current account was equivalent to 21.4 per cent of

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GDP, which is the largest current account share since 2017Q3, and is up from 14.1 per cent in the previous quarter.

Merchandise exports over the period rose 4.6 per cent to €72.3bn, with merchandise imports remaining relatively constant at €26.5bn (-0.9 per cent growth). Similarly, services exports rose 3.8 per cent to €71.4bn, while services imports remained relatively unchanged at €66.6bn (1.1 per cent growth). MNE activity appears to be a key component of these movements, with contract manufacturing exports (in the form of goods for processing) rising by €6.3bn, while royalties/licences imports rose by €1.6bn (with the Pharmaceutical sector accounting for €1.1bn of these imports).

On the Financial Account side, the net lending position remained positive, but declined to just under €13bn. Net other investment asset positions (€22.4bn) was particularly important in explaining the financial account surplus in Q3, outweighing net direct investment (-11.4bn) and portfolio investment (-2.1bn) liability positions.

The current account is expected to expand further at end-2021 and remain in a surplus position. Assuming a moderate impact from the Omicron variant in the final quarter of 2021 and the first quarter of 2022, increased foreign export demand (particularly in the IT and Pharmaceuticals sectors) should cause the current account to remain in surplus over the forecast horizon.

The modified current account is also expected to remain in surplus over the forecast horizon. Having recorded a surplus of 11.5 per cent of GNI* in 2020, the continued strength of the trade balance is forecast to keep the modified current account in surplus over the forecast horizon.

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Box D: The Irish ICT Services Sector during the Covid-19 Pandemic

By Michael O'Grady[13]

The financial and economic effects of the Covid-19 pandemic have been both negative and substantial and are still being felt in most countries. While quantifying the global impact of Covid-19 on output is a complicated process, estimates suggest that the global economy contracted by 3.5 per cent in 2020, relative to the 3.4 per cent growth that had been anticipated prior to the pandemic[14]. Similarly, forecasts for growth in 2021 based on continued strong fiscal supports, the anticipated vaccine-powered recovery in the second half of 2021, and continued adaptation of economic activity to subdued mobility, have subsequently been reduced.[15]

At the country-level, there was considerable homogeneity in the decline/ recovery in consumer demand across industries. Customer-facing services sectors (including accommodation and food services, transportation and travel, and entertainment and recreation activities) suffered the largest negative effects in 2020, while e-commerce, healthcare and pharmaceutical services, and information and communications services have experienced the largest recoveries due to the unique nature of the crisis.

Within the Irish economy, indigenous domestic economic activity experienced a decline in output similar to other countries during the pandemic, while sectors dominated by MNE activity have continued to expand their employment, export and output shares of the aggregate economy. Of these sectors, the Information & Communications Technology (ICT) services sector has shown some of the more remarkable dynamics, further establishing its importance in contributing to domestic macroeconomic conditions.

Figure 1 presents the ICT services sector share of a number of key macroeconomic aggregates over the last decade, including corporation tax, employment, gross value added and output. As can be seen from the chart, the macroeconomic contributions of the sector, as a share of the total economy, have increased markedly over the decade: personal and corporation tax shares have more than doubled between 2011 and 2020, while the share of employment in the sector has risen from 4.7 per cent in 2011 to almost 6 per cent by 2020.

[13] Irish Economic Analysis Division
[14] IMF World Economic Outlook Report, April 2021
[15] Forecasts of 6 per cent global growth in April 2021 were reduced to 5.3 per cent by October 2021, with further downward revisions expected due to the Omicron variant.

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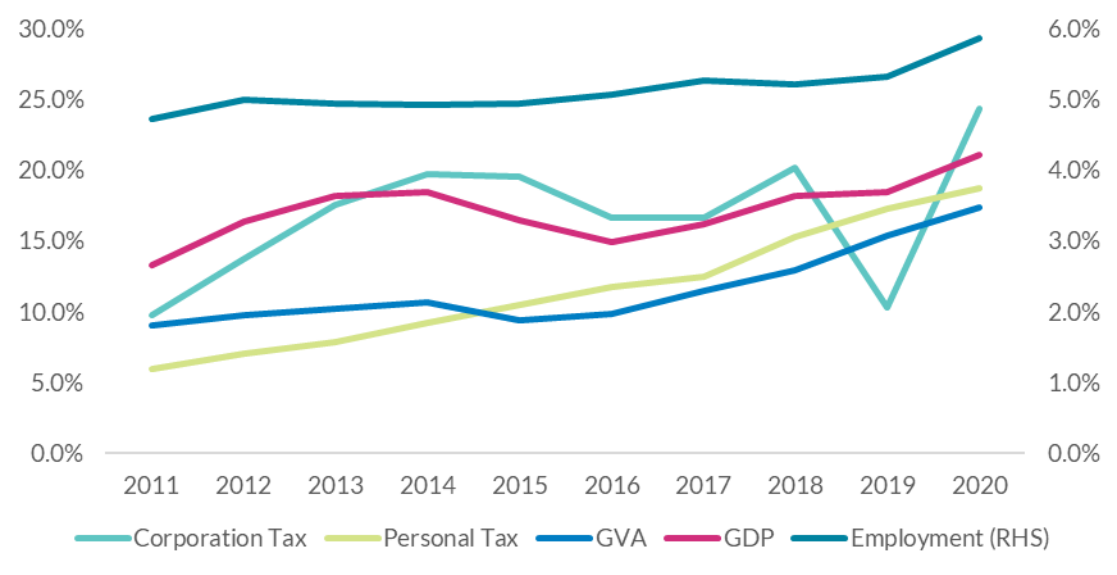
Figure 1: : ICT Services Sector Development, 2011-2020

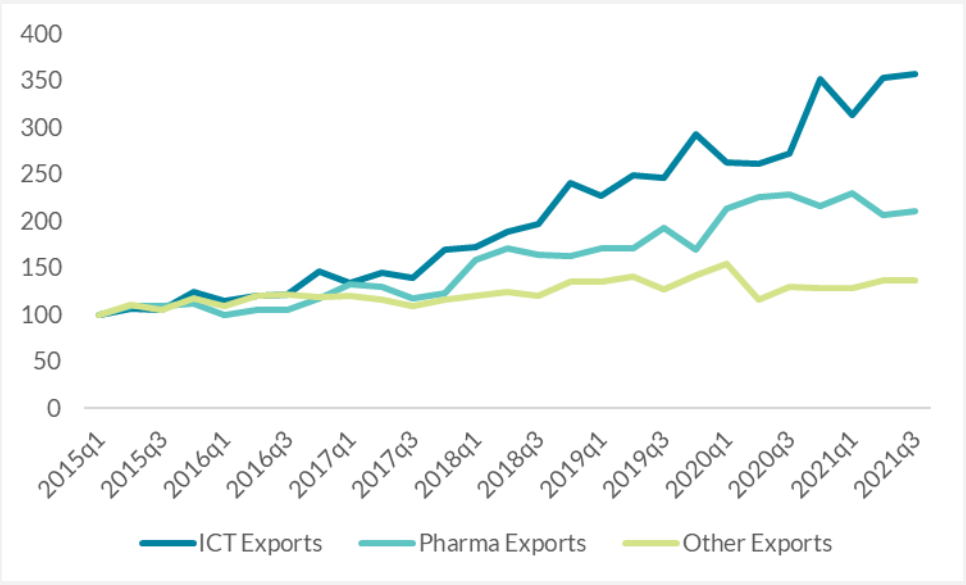


Source: CSO, Revenue and Author's Calculations.
Note: Corporation and Personal Tax, GVA and GDP measured on LHS, Employment measured on RHS

Since the emergence of the pandemic in the first few months of 2020, Information and Communications (ICT) services has been one of the strongest performing sectors in the Irish economy. Combined with growth in the production of pharmaceutical and medical products, the ICT services sector has been a key driver of Irish export volumes, with annual growth of 13% in 2020, and stronger growth rates projected for 2021 (Figure 2).

Figure 2: Export Growth, Pharmaceuticals and ICT Services

Chart: Index of Volume Growth



Source: CSO, WTO and Author's Calculations

Despite this exceptional growth in growth of ICT services exports, the net benefit to the Irish economy is considerably lower than Figure 2 would suggest, as there is typically a

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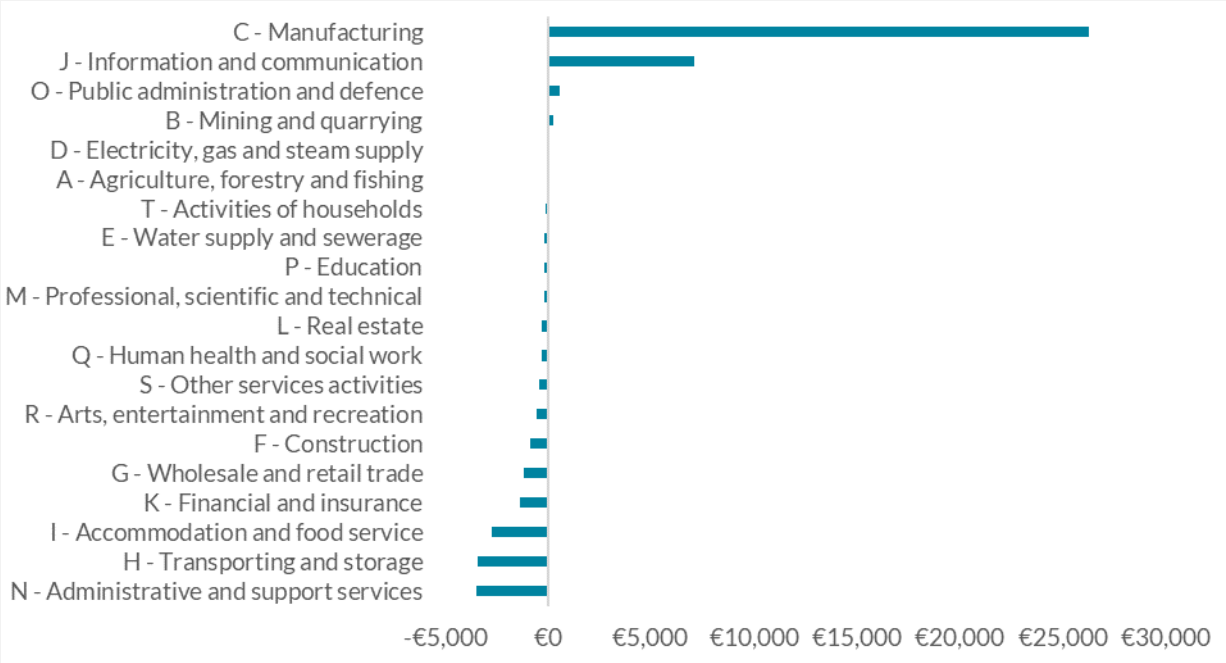
counter-balancing ICT services import of royalties and licenses. Typically, the Irish operations of MNEs have to pay for the technology they use, either through the outright licence purchase of the technology or via recurrent royalty payments, both of which classify as ICT imports. Since 2017, the share of overall royalties and licenses imports accounted for by the ICT sector has risen from just over 50 per cent to 67 per cent of total volumes. While the high import content of ICT services exports reduces the sector's impact on the domestic economy, the sector has still contributed positively to the domestic economy during the Covid-19 pandemic as reflected in a number of other important economic metrics including employment and employee earnings data.

Figure 3 shows the contribution to growth in Irish GVA using detailed sectoral data from the CSO for 2020. With 16 of the 20 sectors experiencing a decline in value-added relative to 2019, ICT services experienced the largest increase in GVA after the manufacturing sector. Value added increased by €7.1 billion (compared to a €9 billion increase in 2019), accounting for 37.3 per cent of the increased in value added between 2019 and 2020, and 16.5% of total-economy GVA in 2020.

Figure 3: ICT services contributed significantly to measured economic growth in 2020

Chart: GVA Growth (constant €mil)



Source: CSO
Note: The euro amounts correspond to growth of 14% in ICT and 23% in Manufacturing.

Similarly, Figure 4 shows annual sectoral GVA growth rates for 2019 and 2020, with spheres representing the relative size of 2020 GVA levels in each sector. As can be seen

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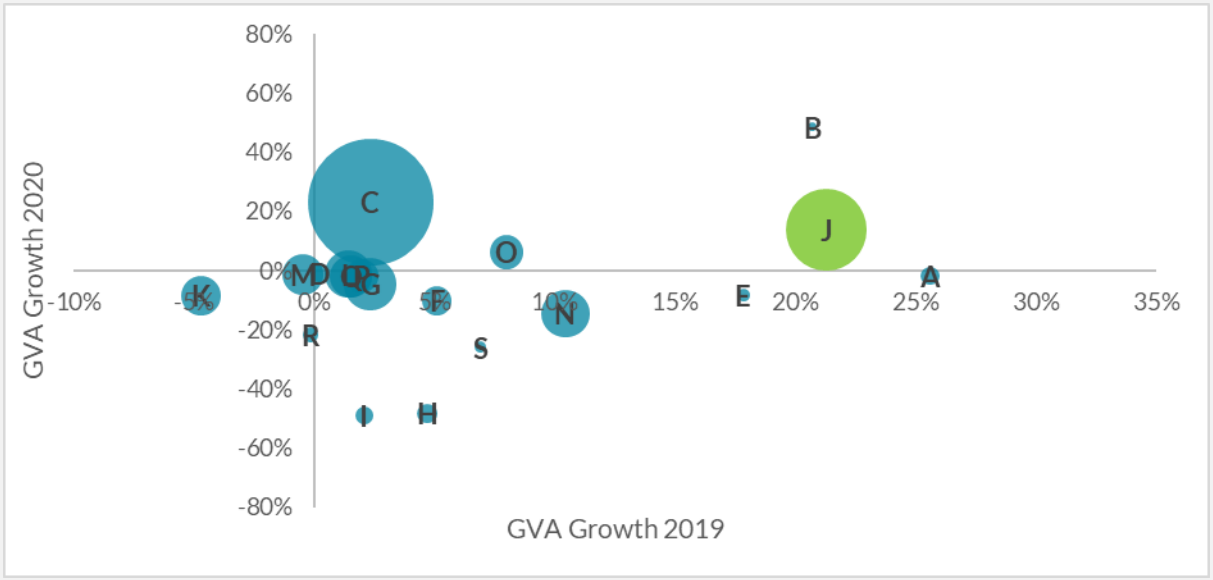
from the chart, the ICT sector (J), is one of only four sectors with positive GVA growth in both years, and the sector with the second-largest cumulative GVA growth rate.

Figure 4: ICT outperforming most sectors in GVA growth terms

Chart: Sectoral GVA Growth 2019-2020



Source: CSO and Author's Calculations

Looking only at value added can potentially provide a misleading indication of the contribution of the ICT sector (or any MNE-dominated sector) to the Irish economy. In particular, profits account for a large share of GVA and these are ultimately repatriated to the foreign owners of the MNEs. To more accurately assess the impact of the sector, it is necessary to examine the other channels through which the ICT sector provides real, tangible benefits to the Irish economy.

Figure 5 shows the rate of employment growth across NACE sectors for 2019 and 2020. ICT services (J) stands out as being one of the more robust sectors in weathering the effects of the pandemic, with the largest employment increase (8,596 jobs) in 2020, and the second-largest cumulative increase (19,727 jobs) across the 2020-2021 period.

In addition to the increasing number of jobs created in the ICT sector, Figure 6 shows the growth rate of weekly earnings in ICT-related jobs across 2020 and 2021. Again, the sector performs strongly over the period, with average annualised growth rates of over 4.5 per cent. Additionally, average weekly earnings (reflected in sphere size in Figure 6) are higher than any other sector. This positive real wage growth and high average earnings should continue to attract employees into the sector, further enhancing the importance of the sector to the domestic economy.

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Figure 5: ICT a key sector in overall employment growth over 2020 and 2021.

Chart: Sectoral Employment Increase (000s of additional employees), 2020-2021

Source: CSO and Author's Calculations. Data available up to 2021Q3.

Figure 6: Earnings growth has also been significant in the ICT sector

Chart: Sectoral Earnings Growth 2020-2021*

Source: CSO and Author's Calculations. Data available up to 2021Q3.

Finally, Figure 7 shows net tax receipts for earned income and corporation taxes in 2020. The importance of the ICT sector is readily apparent from the data, contributing more revenue to the exchequer from combined earnings and corporation tax receipts (€5bn) than any other sector with the exception of Manufacturing.

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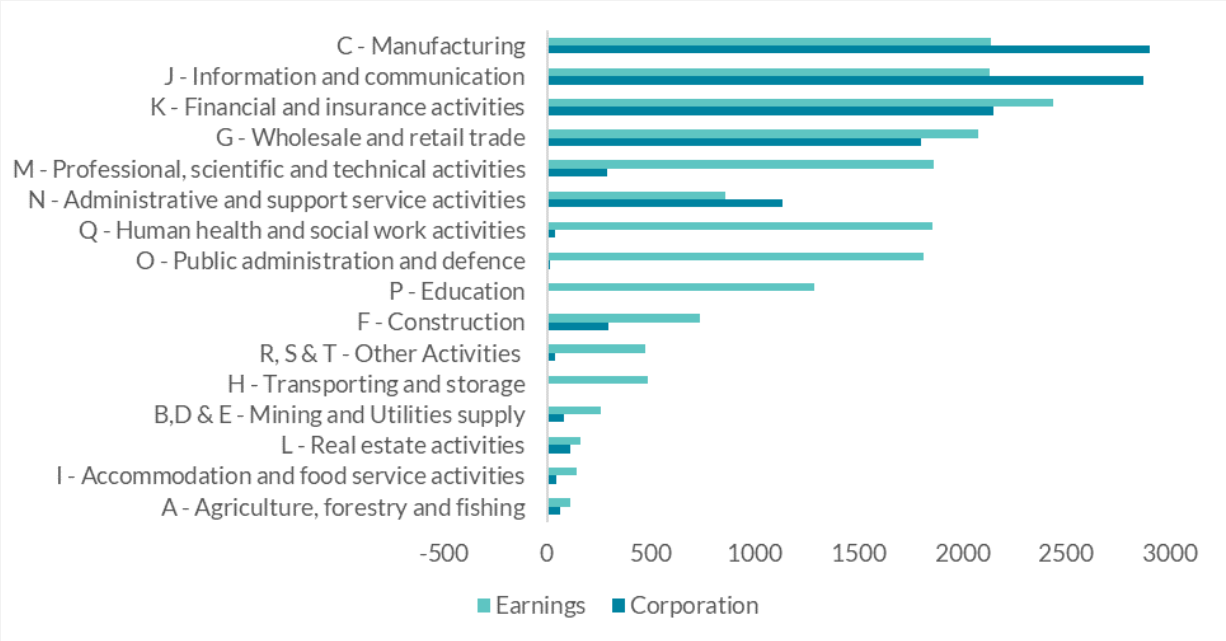
Figure 7: Sectoral Tax Receipts, 2020

Chart: Corporation and Personal Tax Receipts, €mil



Source: Revenue

While there has been considerable discussion of the distortionary effects of MNE activity in the ICT sector on the national accounts in recent years, it continues to have a strong, real presence in the domestic economy, responsible for a significant share of value-added, employment and productivity growth during the Covid-19 pandemic. The activities of these MNEs contribute positively to the performance of the Irish economy, with further second-round effects in the form of forward and backward economic linkages, plus the associated personal and corporate tax revenues deriving from their domestic operations.

Prices and Costs

The rate of consumer price inflation is forecast to remain higher for longer compared with the forecasts in the previous *Bulletin*.
Inflation increased during 2021 driven by rising energy prices, the rapid recovery in the domestic economy, supply bottlenecks and base effects relating to weak price trends in 2020. The Harmonised Index of Consumer Prices (HICP) ended 2021 with an increase of 5.7 per cent year-on-year in December. The average for the year was an increase of 2.4 per cent (Figure 22).

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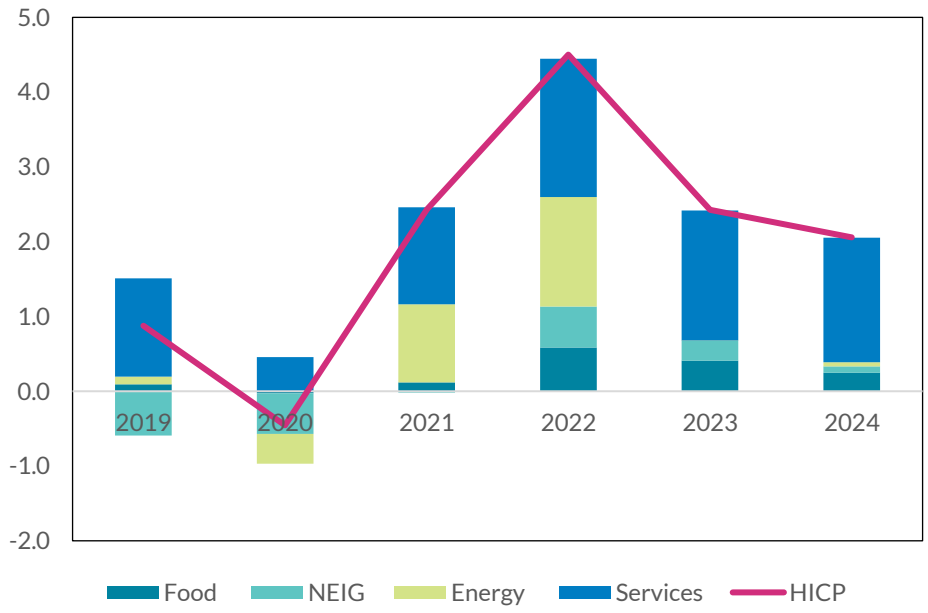
Driven by increases in international oil and liquid natural gas prices, energy prices for consumers rose by 30 per cent year-on-year in December 2021. These international commodity price developments passed through to consumers in the form of higher prices for petrol, diesel, home heating oil, gas and electricity bills (Figure 23). Market expectations, measured by the price of futures contracts for oil and other energy commodities, are for these wholesale prices to decline in the second half of 2022 (Figures 24-26). However, increases in carbon taxes and the lag in the passing through of wholesale energy prices to producer and consumer contracts mean that energy prices are likely to remain elevated for some time to come.

Inflation will begin to decelerate in the second half of 2022, as energy prices begin to normalise

Figure 22: Headline Inflation Contributions



Source: Eurostat and Central Bank of Ireland calculations

Supply bottlenecks, both domestically and internationally, continue to drive up input prices in a number of sectors and these prices will continue to feed through to consumer prices (Figure 8). Internationally, prices of many raw materials and commodities, including for food, have increased substantially since the onset of the pandemic. In Ireland, the prices of construction materials like concrete, steel, timber and cement have increased substantially as global demand surged. The shortage of microchips continues to

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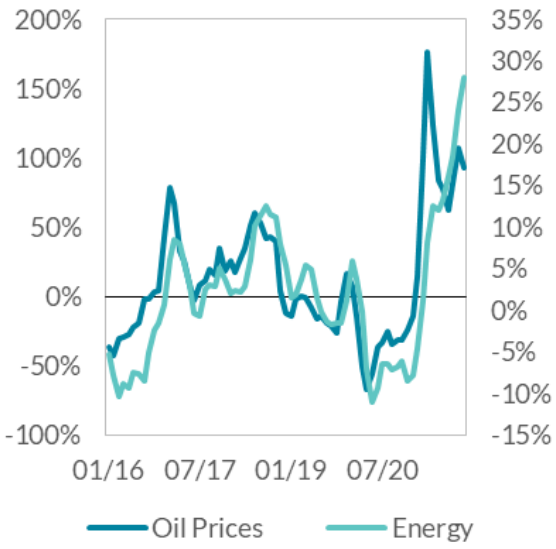
weigh on the price of certain manufactured goods such as cars and durable goods, leading to price rises. The price of containerised shipping has fallen sharply compared with 2021, but remains above its historical trend level.

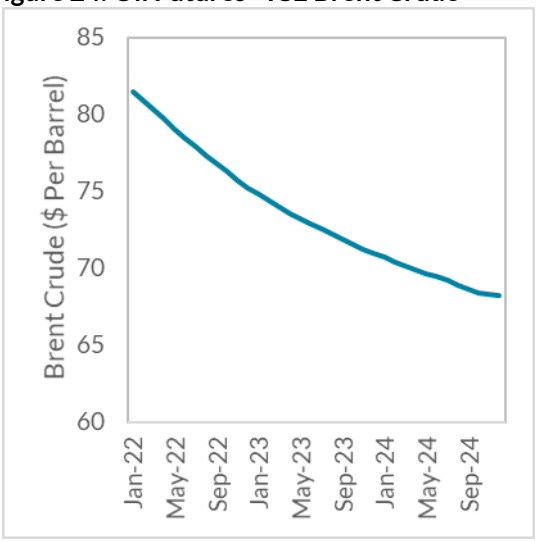
Energy price inflation has been historically high in recent months, but futures prices suggest markets expect prices to decline in 2022

Figure 23: Oil Prices and HICP Energy



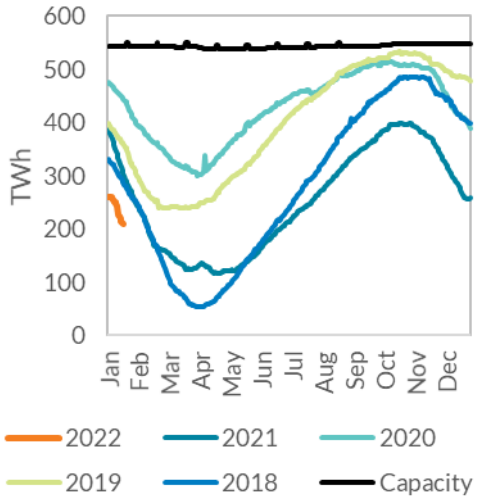
Source: Eurostat

Figure 24: Oil Futures– ICE Brent Crude



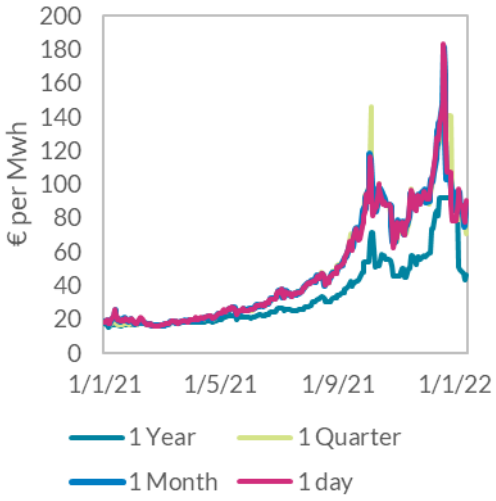
Source: Refinitiv

Figure 25: Aggregated Northwest European Gas Storage by Month



Source: Refinitiv

Figure 26: Natural Gas Price Futures



Source: Refinitiv

The rate of inflation is forecast to peak in the first quarter of 2022, remain above 5 per cent for the second quarter and to decline materially in the third and fourth quarter of 2022. Inflation prospects this year reflect the atypical nature of the pandemic, while

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prospects for later in the horizon should return to the more macroeconomic fundamentals of an economy growing at or above potential. Headline HICP inflation is expected to average 4.5 per cent this year, moderating to 2.4 per cent in 2023 before easing to 2.1 per cent in 2024. Core inflation, excluding food and energy prices, is forecast to increase by 3.4 per cent in 2022 and 2.9 per cent and 2.5 per cent in 2023 and 2024, respectively.

Table 2: Inflation Projections

	2021	2022	2023	2024
HICP	2.4	4.5	2.4	2.1
Goods	2.1	5.1	1.3	0.8
Energy	13.1	18.3	0.0	0.7
Food	0.6	2.7	1.9	1.1
Non-Energy Industrial Goods	-0.1	2.4	1.2	0.4
Services	2.4	3.9	3.6	3.5
HICP ex Energy	1.5	3.3	2.6	2.2
HICP ex Food & Energy (Core)	1.7	3.4	2.9	2.5
Modified Domestic Demand Deflator	2.6	4.9	3.6	3.0
Private Consumption Deflator	3.0	4.6	3.2	2.8
Modified Investment Deflator	3.8	7.2	5.0	4.0

Source: Central Bank of Ireland

Risks to the inflation forecasts remain tilted to the upside. The effects of Omicron and any further waves of Covid-19 that may occur increase the risk that supply bottlenecks persist longer than anticipated, adding to the costs of consumer goods and services. Energy price developments also present an upside risk to inflation rates with geopolitical uncertainties particularly relevant at present. If domestic demand continues to grow, prices could rise by more and for longer than expected. With both monetary and fiscal policies remaining accommodative, and with many sectors increasingly operating with relatively little slack, demand could result in stronger nominal growth. Differing international monetary responses could also put further pressure on prices through the exchange rate

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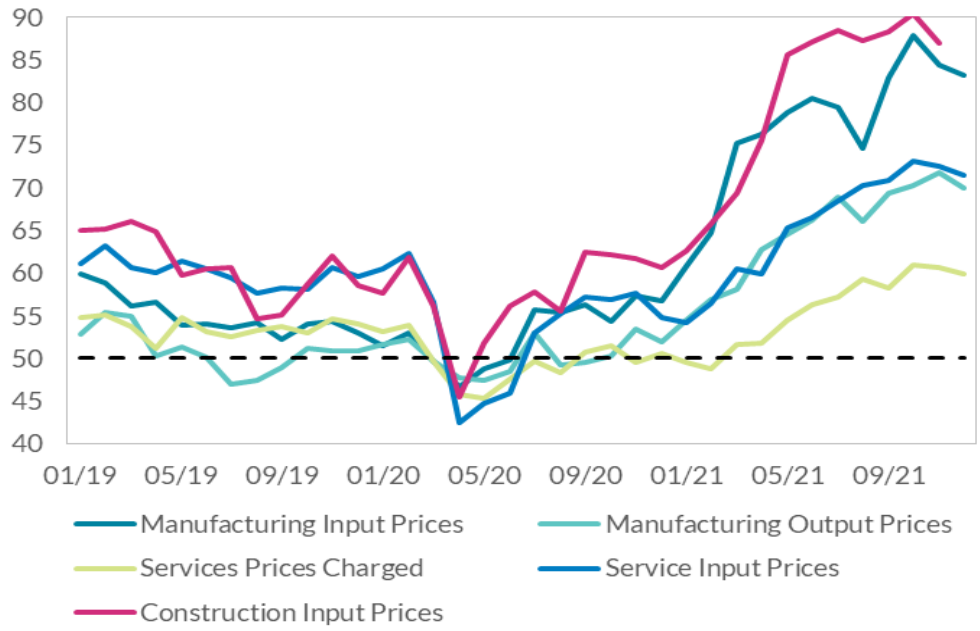
channel. Most importantly, while there is some evidence of wage pressures emerging, wage increases are not currently broadly-based, reflecting labour shortages and productivity increases in some sectors rather than generalised cost of living increases. The dynamics between wages and prices, nevertheless, could influence future inflation developments.

Broader Costs in the Economy

Input and output prices in the manufacturing, services and construction sectors all point towards continued supply constraints and upward price pressures in the months ahead. While the index for input costs and prices declined slightly, the PMIs in December 2021 remained at historical highs for both input and output prices (Figure 27).

Broader measures of costs in the economy also picked up during 2021

Figure 27: PMI Input and Output prices



Source: Markit

Cost pressures are more evident for indigenous firms, which may have less scope than foreign-dominated sectors to absorb rising costs through margins rather than passing on in the form of higher prices to customers. Data from the National Accounts suggest output prices for domestically focussed sectors dominated by Irish firms is rising. Inflation is also evident in other price measures, including agricultural prices, domestic wholesale prices, property

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prices and asset prices. The rise in these measures reflects the broad-based nature of price increases across the economy expected in the medium term.

Box E: Relative vs General price changes - estimating the common component of inflation for Ireland

By John Scally and Graeme Walsh[16]

Understanding the drivers of the increase in inflation in 2021 and the extent to which these reflect temporary factors in specific parts of the consumption basket or more persistent and more generalised factors is currently an important issue facing central banks in the euro area and elsewhere. This Box estimates a measure of underlying inflation for Ireland known as the common component of inflation.[17] The common component of inflation allows us to distinguish between broad-based changes in the general price level from idiosyncratic temporary relative price changes, and can be used as a data-driven tool to monitor risks to the inflation outlook. [18] This is particularly important during the current period of high levels of uncertainty around the inflation outlook.[19]

The basic idea behind the common component of inflation is to filter out temporary idiosyncratic shocks to headline inflation and to help identify structural, or underlying, inflationary pressures. Core inflation represents a similar idea by excluding the volatile series of food and energy prices, but includes temporary idiosyncratic changes to the other components of the HICP. In contrast, the common component excludes the temporary idiosyncratic component from each series in the HICP (see Table A). For example, a temporary tax cut for a specific good or a short-term supply disruption could change core inflation but not the common component. As such, core inflation is an imperfect measure of general changes in the price level in that temporary shocks in sectors other than food and energy may be misunderstood as economy-wide shocks. On the other hand, the common component seeks to present inflation driven by general increases in consumer prices, which could, for example, coincide with second round effects to wages.

[16] Irish Economic Analysis Division.
[17] In this box, inflation refers to HICP inflation. The common component is estimated up to November 2021.
[18] The methodology we use follows Nir, Haberkorn, and Cascaldi-Garcia (2021). https://www.federalreserve.gov/econres/notes/feds-notes/international-measures-of-common-inflation-20211105.htm
[19] https://www.centralbank.ie/news/article/speech-inflation-dynamics-in-a-pandemic-maintaining-vigilance-and-optionality-gabriel-makhlouf-23-november-2021

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Table A: Treatment of temporary shocks by different measures of inflation

Inflation measure	Temporary Shocks
Headline	Includes all
Core	Excludes food and energy only
Common	Excludes all

The methodology we use follows Nir, Haberkorn, and Cascaldi-Garcia (2021). The analysis allows for developments in each sub-index of the HICP to be decomposed into (1) a common trend across all sub-indices and (2) idiosyncratic movements. The common trend in each sub-index is then aggregated using the standard HICP weights to arrive at the estimate of overall common HICP inflation. The difference between headline HICP and the common component is the inflation arising from idiosyncratic shocks.

Figure A shows headline and core inflation along with the estimated common component of inflation for Ireland over the 2003-2021 period. The common component is shown to be less volatile than both headline and core inflation. For example, headline and core inflation experienced large inflationary and deflationary swings around the period of the 2008 economic crash, reaching up to 4 per cent in 2007 and falling below -3 per cent in 2009. This volatility is in contrast to the common component of inflation, which gradually moved from a steady pre-crisis average value of around 2 per cent to a relatively stable post-crisis average of 1.1 per cent. Despite these different dynamics, the traditional measures of inflation and the common component tend to converge over the medium-run.[20]

Figure B focuses on the recent pandemic period (2020-2021) and shows headline and core inflation, and the common component of inflation for Ireland. In January 2020, headline, core, and common inflation stood at 1.1, 0.7, and 1.1, respectively. In 2020, headline and core inflation took a deflationary swing falling below -1 per cent reflecting the initial negative impact of the pandemic on demand. In 2021, this deflationary trend ended abruptly with the rates of both headline and core inflation surging, to their highest levels since June 2001. The latest data for November 2021 show headline and core inflation at 5.4 and 3.6 per cent, respectively.

In contrast to these volatile swings in headline and core inflation measures, the common component of inflation has been relatively more stable. The common component fell to a low of 0.9 per cent during the pandemic and over recent months has returned to its pre-

[20] Preliminary analysis of cross-correlations suggests that there is typically a lag of around 12 months between headline measure and the common measure, such that they are likely to converge at some point in between their current levels over the forecast horizon.

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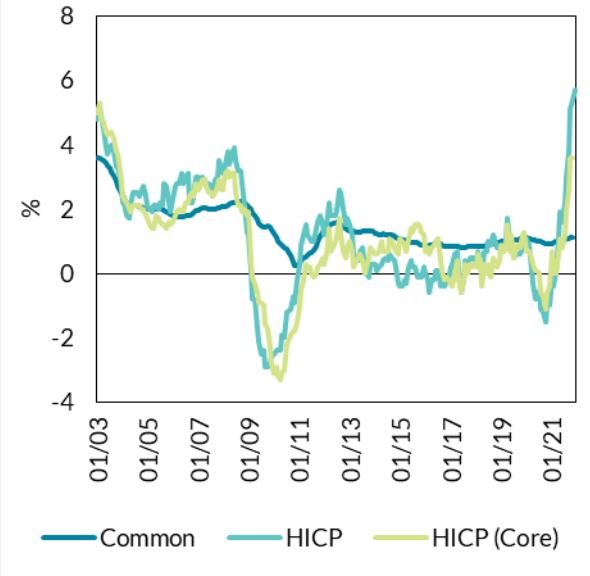
pandemic level of 1.1 per cent. Figure B decomposes overall headline inflation into the contribution from the common component and the idiosyncratic component. The idiosyncratic component is the part of inflation explained by short-run shocks or changes in relative prices. As shown in Figure B, the upsurge in inflation in 2021 is largely explained by an increase in the contribution of the idiosyncratic component rather than a rise in the common component.

Figure A: Common inflation is less volatile than headline and core

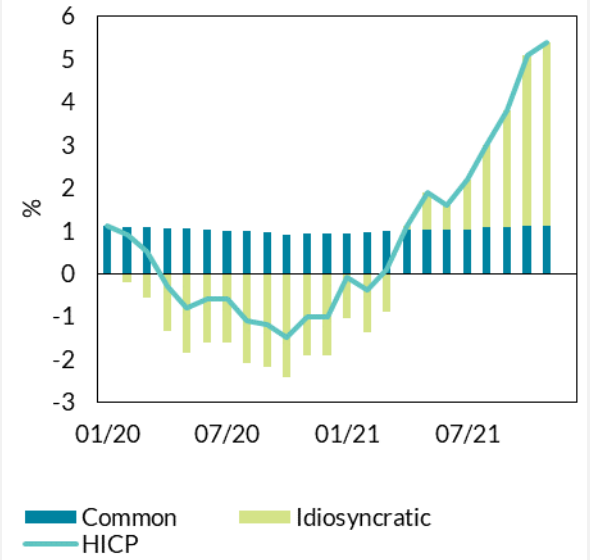
Chart: Measures of Inflation



Source: author's calculations.

Figure B: Recent inflation surge is largely explained by the idiosyncratic component

Chart B: Decomposition of HICP



Source: author's calculations.

To help understand the recent drivers of the common and idiosyncratic components of inflation, Figure C starts by showing the contributions to the idiosyncratic component – the main driver of recent overall inflation. The largest contributions in November were Food and non-alcoholic beverages (0.78), Transport (0.53), followed by Restaurants and hotels (0.50). These contributions reflect short-term shocks to these categories of inflation as well as base effects. Figure D shows the contributions to the common component. The largest contributions in November were Housing, water, electricity, gas and other fuels (0.40), Restaurants and hotels (0.24), and Transport (0.16). These contributions reflect the underlying inflationary pressures and are more specifically relate to higher rents, gas, electricity and fuel prices, which suggests that there have been some recent spillovers from energy prices (normally excluded from core inflation) into underlying inflation.

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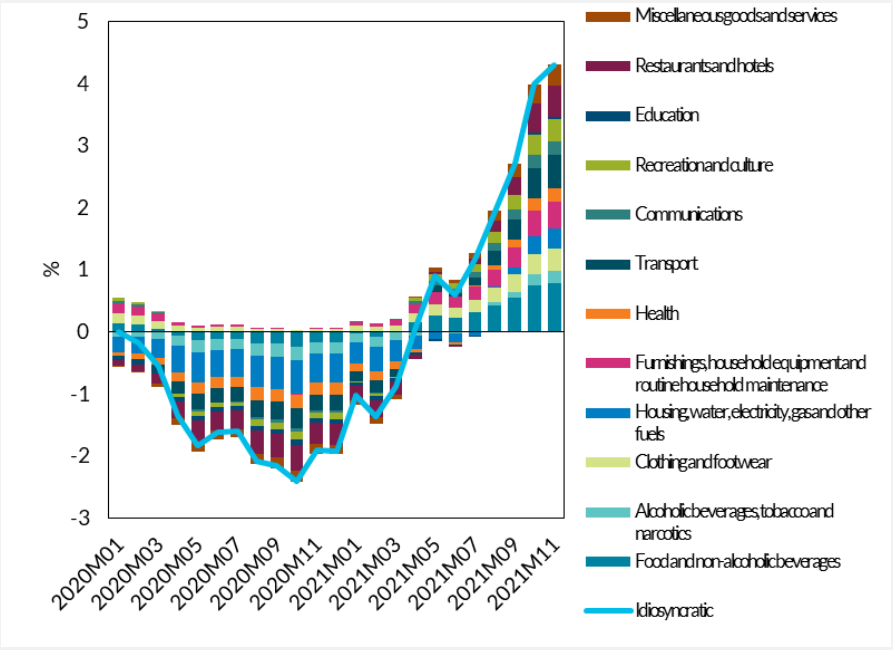
Figure C: Food and energy were the largest contributions to the idiosyncratic component in November

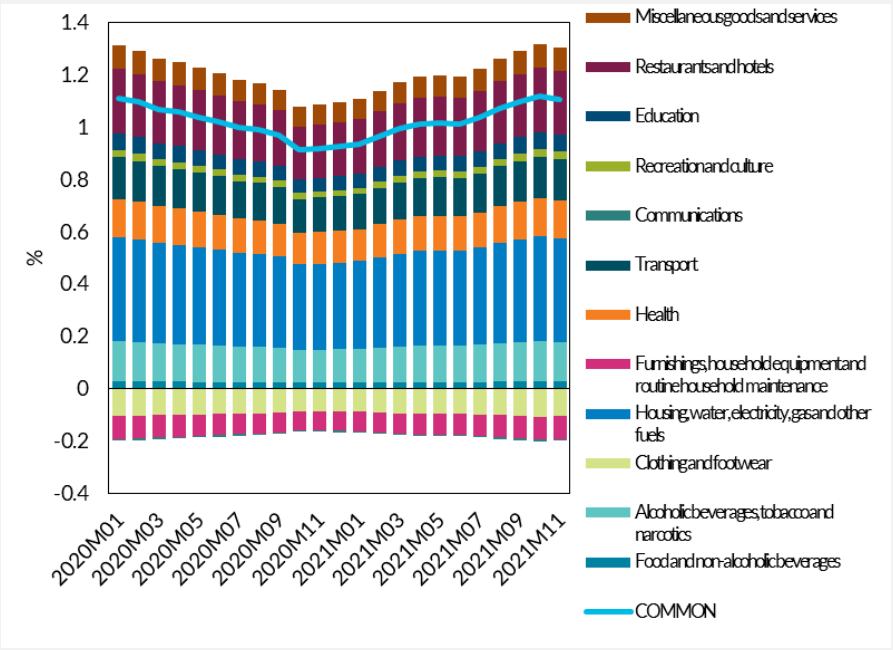
Chart: Contributions to the Idiosyncratic Component



Source: author's calculations.

Figure D: Rents and energy prices were the largest contributions to the common component in November

Chart: Contributions to the Common Component



Source: author's calculations.

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This Box has shown that temporary, relative price shocks, primarily to food and energy prices, were the main factors driving up headline inflation in 2021. The common component of inflation – a measure of underlying broad-based inflationary pressures – has remained relatively stable but has picked up over recent months and is currently at its pre-Covid level of about 1 per cent (see Chart B and Chart D). This is considerably lower than headline inflation of 5.4 per cent. While temporary shocks are expected to dissipate over the forecast horizon, if these were to prove more long-lasting they could feed through to further increases in the common component of inflation and the general price level. This would pose a risk to the inflation outlook and will need to be monitored carefully to help identify evidence of broad-based inflationary pressures.

Box F: Modelling the duration of energy price shocks

By Graeme Walsh[21]

During 2021, there was a large surge in the price of energy commodities. The latest data for November 2021 show that the price of gas in Europe increased by 470 per cent on an annual basis (Figure 1). The price of Brent crude oil and coal were up 87 and 140 per cent, respectively.[22] As discussed in Byrne and Zekaite (2021) and Byrne, Scally and Zekaite (2021), supply and demand factors have both contributed to the recent surge in energy prices and this has created challenges for the global economy, including Ireland. For example, on the demand side, there was a strong recovery in global economic activity due to the easing of restrictions and vaccine rollout and increased demand due to weather related events, such as unusually cold temperatures in Europe and hotter summer conditions in other parts of the world. On the supply side, there have been disruptions to the supply of natural gas, lower coal production in China, and reductions in investment in oil and gas extraction.

[21] Irish Economic Analysis Division.
[22] These figures refer to the average price of Australian and South African thermal coal.

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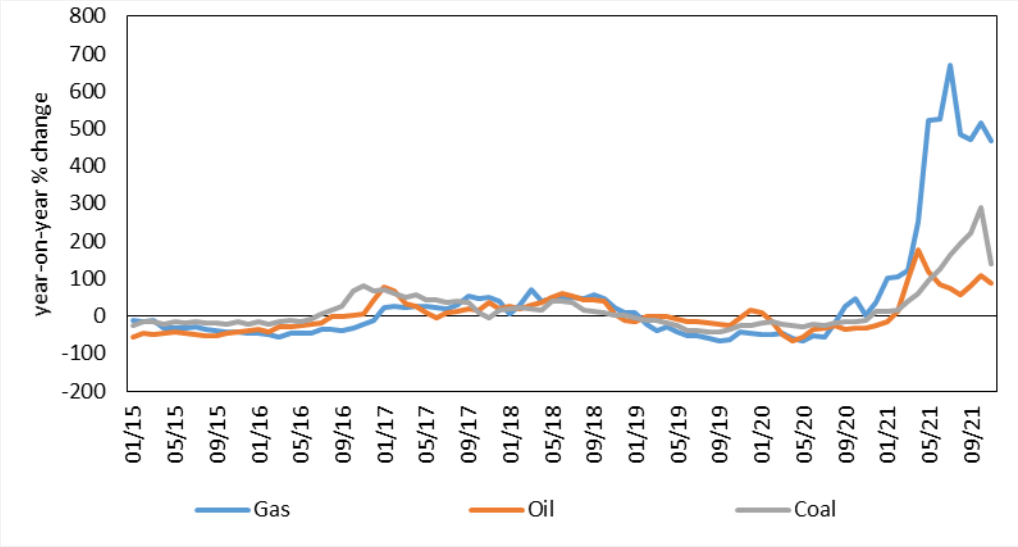
Figure 1: Energy commodity prices surged in 2021

Chart: Energy commodity prices 2015-2021 (November)



Source: IMF (https://www.imf.org/en/Research/commodity-prices).

This box investigates the impact of an exogenous increase in the price of energy on the Irish economy using NiGEM and COSMO.[23] This scenario is one of the key risks to the inflation outlook that could arise, for example, due to geo-political factors or changes to the weather and climate change. The purpose of the scenario is to assess the impact of higher commodity prices on inflation. However, this is an illustrative scenario and should not be a viewed as a forecast of future likely developments in commodity markets.

Modelling Assumptions

Using NiGEM, we simulate the effect of an exogenous 100 per cent increase in the price of energy (oil, coal, and gas).[24] To demonstrate that the persistence of the price increase matters, we consider two scenarios where the shock lasts 1 year and 3 years.[25] We also assume that monetary authorities view the shock as temporary in nature and do not respond by raising interest rates in response to higher inflation. Moreover, we do not include other potential policy responses such as stockpile releases and fuel subsidy payments to households. It is important to note that the underlying cause of the price

[23] NiGEM is a global economic model developed by the National Institute of Economic and Social Research in the UK. The model documentation can be found at: https://nimodel.niesr.ac.uk/ COSMO is a model of the Irish economy used by the Central Bank (see Bergin et al (2017) and Conefrey, O'Reilly and Walsh (2018)).
[24] Note that the Department of Finance Budget 2022 Economic & Fiscal Outlook includes a simulation of the impact of a 50% oil price shock using COSMO.
[25] The baseline scenario can be interpreted as a scenario without any shocks. The baseline scenario assumes that the price of oil is $60 per barrel. The base price of coal and gas is equivalent to $49 and $18 per barrel, respectively. The simulation results are independent of the baseline assumptions.

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increase matters, meaning that scenarios driven by supply or demand shocks are different from exogenous shock scenarios (see Kilian 2009).[26] The methodology we use is similar to Alonso and Suárez-Varela (2020).[27]

Transmission Mechanisms

In NiGEM, higher energy prices affect the economy through a number of channels. Higher energy prices improve the terms of trade for energy exporters, but worsen the terms of trade for energy importers. Energy is included in the production function and higher energy prices reduce the demand for energy and thus lower potential output. An increase in energy prices result in higher import prices and depending on the type of shock can also pass through to consumer prices. From the Irish perspective, the impact of the shock depends crucially on how the global economy and our main trading partners, in particular, respond.

Simulations Results

The NiGEM simulations show that the energy price shock would lead to higher inflation in our main trading partners. On impact, inflation in the euro area, US and UK increases by 4.0, 4.6 and 2.6 percentage points in the first year, respectively. This initial inflationary spike fades out after 1-2 years of the initial shock. These inflation dynamics are similar to those found in Kilian and Zhou (2021). The shock also has an adverse effect on economic activity in our main trading partners with GDP falling by up to 0.4 per cent in the euro area and 0.6 per cent in the US. The UK is an exception with GDP remaining broadly unchanged over the shock period reflecting an energy and trade mix that is less exposed to the shock compared to the euro area and US. Taken together, these price and activity effects imply that the Irish economy would directly face higher imported inflation and a reduction in foreign demand for Irish goods and services.

Figure 2 shows the estimated inflation response for Ireland using COSMO. On impact, inflation increases by 2.7 percentage points, which is generally lower when compared to our main trading partners. This is in part due to the varying energy mix by country and the higher intensity of fossil fuel use abroad, particularly by heavy industry. Moreover, the reduction in foreign demand is larger for Ireland and this partially offsets some of the inflationary pressures. The results, which take into account both the impact of higher imported inflation and the impact of higher costs in the domestic economy, show that the inflationary effects of the shock ease over time and tend to have diminished about 1-2 years after the shock. In the scenario where the shock lasts one year, inflation increases by 2.7 p.p. in the first year before falling to 0.6 p.p. in the second year. In the other

[26] Kilian (2009) Not All Oil Price Shocks Are Alike: Disentangling Demand & Supply Shocks in Crude Oil Market.

[27] Alonso and Suárez-Varela (2020) Box 2 An analysis of the global economic impact of the recent increase in energy commodity prices and Kilian and Zhou (2021) The Impact of Rising Oil Prices on U.S. Inflation Expectations in 2020-23.

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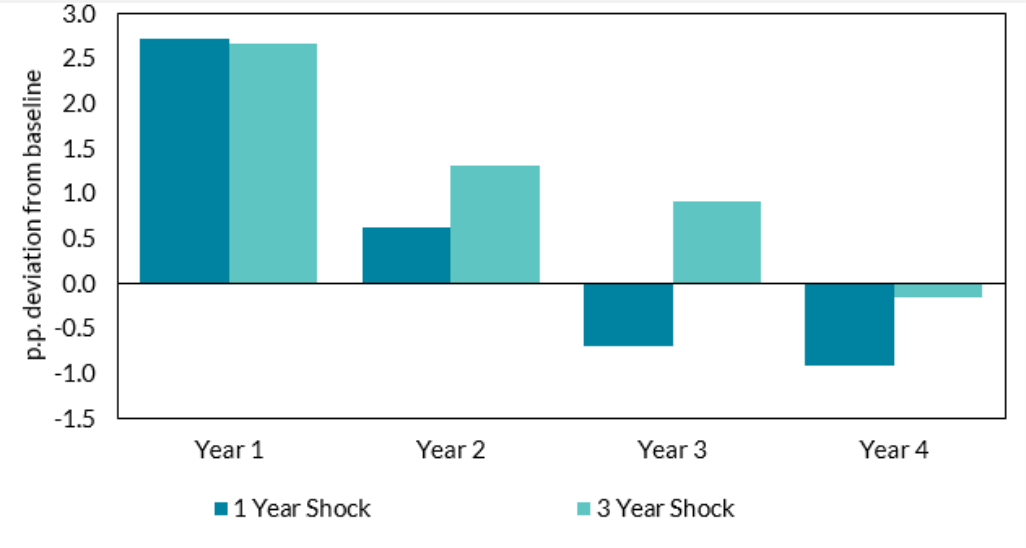
scenario where the shocks lasts three years, inflation increases by 2.7 p.p. in the first year and is more persistent in the second and third years where it increases by 1.3 and 0.9 p.p., respectively. In both scenarios, the price level increases, but gradually returns to the baseline after the shock owing to the temporary nature of the shock. The projections in this *Bulletin* assume that energy prices begin to moderate in 2022, contributing to an expected reduction in inflation over the projection horizon. This analysis demonstrates the potential risks to the inflation outlook in the event of further increases in energy prices.

Figure 2: The initial inflationary spike fades out 1-2 years after the shock

Chart: Impact of shock on Irish inflation



Source: COSMO, authors' calculations.

Labour Market

Employment projections have been revised upwards to reflect two consecutive quarters of unprecedented growth. Employment increased annually by 9.9 and 9.8 per cent in Q2 and Q3 2021, respectively, to reach a new peak of 2.47 million, some 113,000 persons above the pre-pandemic level. The recent increase was driven predominantly by female and younger cohorts. Overall, the employment profile has broadly returned to the projection path expected prior to the onset of Covid-19 as the labour market begins to tighten amidst staff shortages across a number of sectors.

Employment levels returned to or exceeded pre-pandemic figures in eleven of the fourteen NACE sectors in Q3 2021. Administration

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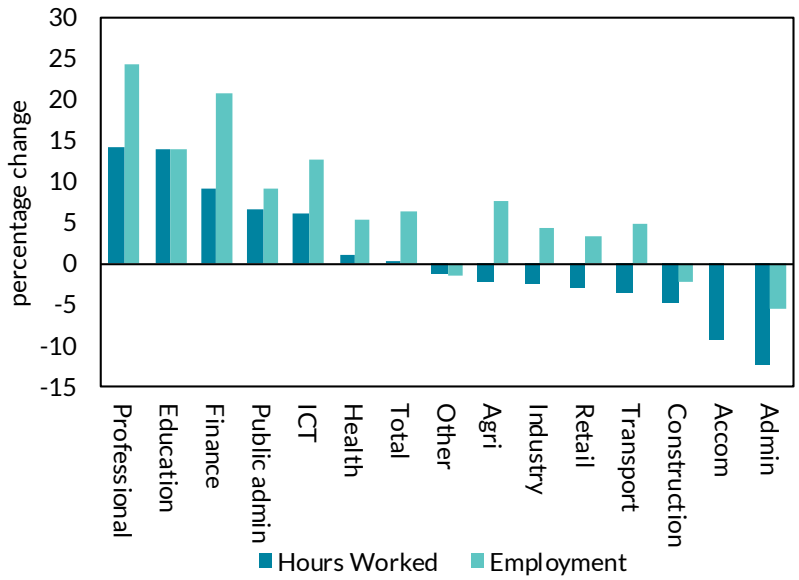
(-5.6 per cent), Construction (-2.3 per cent) and Other services (-1.3 per cent) remain below Q3 2019 levels as pandemic-related effects or labour supply issues may still be curtailing employment growth. The recovery in total actual hours worked shows that aggregate levels are 0.1 per cent above the pre-pandemic period with diverging trends evident between sectors (Figure 28). The greater relative increase of part-time workers in contact-intensive sectors in the most recent data has seen changes in hours worked trail employment growth. Sectors less affected by pandemic measures have continued to record strong growth such as Professional services (14.3 per cent) Education (14 per cent), Finance (9.2 per cent) and ICT (6.1 per cent).

Contact-intensive sectors yet to recover to pre-pandemic levels of hours worked

Figure 28: Change in hours worked and employment by sector (Q3 2019 – Q3 2021)



Source: CSO

While a number of caveats exist regarding the interpretation of labour market data at present, changes in sectoral employment levels will continue to be observed in the forthcoming quarters as income supports gradually unwind and pandemic-related distortions lessen. Several elements of this recent growth may be suggestive of structural changes in the labour market as employment growth has been stronger in less adversely affected sectors (See Box G). Approximately 278,000 workers were in receipt of the Employment Wage Subsidy Scheme (EWSS) in December 2021, of which the Accommodation and Food services sector accounted for

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40 per cent.[28] The EWSS contributed 4.7 per cent of total earnings in Q3 2021 while supporting 15.7 per cent of employment suggesting these supports are focused towards relatively lower-earning or part-time employment.[29] The scheme has been extended to April 2022, although it remains to be seen how firms will adjust employment levels or hours worked as supports are tapered to a lower flat rate system.[30] The viability of part-time employment roles in contact-intensive sectors recently filled by younger workers may be vulnerable as firms realise full wage costs in addition to addressing warehoused debt. Downside risks to employment growth in sectors less adversely affected by the pandemic may arise if labour supply shortages coupled with supply chain disruptions and rising input costs impair the ability of firms to expand further. As recent developments may signify structural change in certain areas of the labour market combined with uncertainty as supports are wound down, employment growth is projected to moderate to 3.1 per cent in 2022.

The labour force increased by 7.9 per cent annually to Q3 2021 with a large rise in the participation effect for a second consecutive quarter to counteract reduced inward migration flows. The labour force participation rate (LFPR) of 65.2 per cent is just 1.7 percentage points below its pre-crisis peak. Female participation has been the major contributor to this increase, reaching a new high of 60.1 per cent, and driven by rising employment in high-skilled sectors (Box G). Participation levels are higher across all age categories, particularly amongst younger age cohorts (Figure 29). The rise in the 15-19 years age category accounts for a sizeable share of aggregate part-time employment gains and is mainly focused in contact-intensive sectors. While annual average employment levels broadly converged to pre-pandemic estimates in 2021, the LFPR has experienced a much stronger increase than anticipated. The participation effect has markedly increased in the absence of a stronger demographic effect brought about by lower inward migration levels (Figure 30). Looking ahead, the demographic effect is expected to contribute to a greater extent in labour force growth as net inward migration returns to pre-

[28] See Revenue Covid-19 Support Schemes Statistics
[29] CSO Labour Insights Bulletin, Series 9 Q3 2021
[30] A two-rate structure of €151.50 and €203 will apply from February 2022. This will then be tapered to a lower rate of €100 for March and April.

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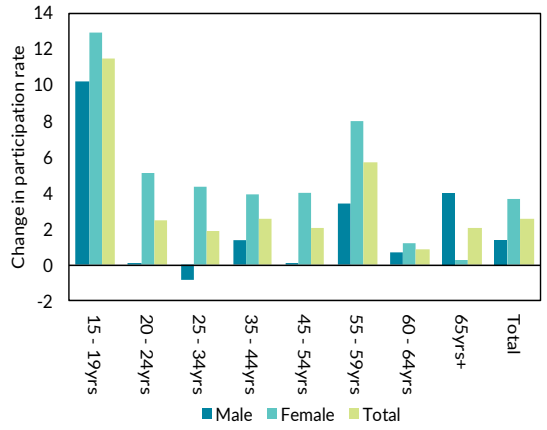
pandemic levels over the forecast horizon and uncertainty regarding the participation rate effect eases. Growth rates of 2.5 and 1.5 per cent are projected for the labour force in 2022 and 2023, respectively.

Participation increased strongly across all age groups

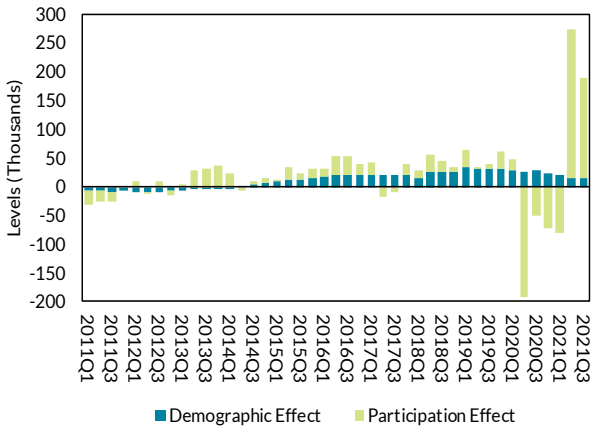
Figure 29: Change in Labour Force Participation by Age Group (Q3 2021 – Q3 2019)



Source: CSO

Strong labour force growth as participation effect counteracts lower net inward migration

Figure 30: Decomposition of Labour Force Growth



Source: CSO

Unemployment rates have fallen markedly through 2021, and the standard measure is expected to be 4.6 per cent by end-2024. The monthly ILO unemployment rate for December 2021 declined marginally to 5.1 per cent, with the Covid-adjusted rate measuring 7.5 per cent. The recent re-opening of the PUP scheme to workers affected by the introduction of health measures in December led to an increase in levels, although the scheme is currently planned to be phased out in February 2022. While measures of labour market slack such as the Potential Additional Labour Force have reverted to pre-pandemic levels, unemployment is still 21,000 persons above the Q3 2019 level, suggesting that there exists some remaining additional labour capacity. However, this may be indicative of skills mismatches between sectors or occupations where employment opportunities are more pronounced and the pool of people remaining unemployed. Other barriers to employment may exist at an individual level, such as caring responsibilities or health concerns. Projections for the unemployment rate have been revised downwards over the forecast

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horizon as the ILO unemployment rate is anticipated to average 6.3 per cent in 2021 and 5.8 per cent in 2022 in advance of averaging below 4.9 per cent in 2024.

Earnings

The growth rate in total average hourly earnings in Q3 2021 relative to the pre-pandemic period was 7.8 per cent; however, the data remain distorted by a number of compositional issues. The largest sectoral increase over this period was evident in Administration (11.6 per cent) and Accommodation (9.2 per cent) although this masks a number changes in the underlying EHECS employment data. Administration employment remains 9.8 per cent below its pre-pandemic level and the increase in earnings may be reflective of lower-earning workers flowing out of the sector, which acted to raise the overall average. Increased earnings growth in sectors less affected by the pandemic and displaying relatively strong employment growth such as ICT (8.1 per cent) and Professional services (7.7 per cent) may be indicative of wage pressures in light of longstanding labour shortages that pre-date the pandemic. Overall, the hourly rate of pay is the dominant determinant of most wage growth in the economy, albeit with significant sectoral differences and changes in average hours worked being quite diverse also (Figure 31). While pandemic-related income-support schemes have succeeded in broadly maintaining earnings levels, particularly for those in more adversely-affected sectors, it remains to be seen if sector-specific wage pressures in those less adversely-affected sectors will spill-over to wider economy wage growth as the labour market continues to tighten.

The job vacancy rate from CSO EHECS data has increased to a new high of 1.5 per cent with certain measures of labour market capacity signalling renewed tightness. Higher job vacancy rates are observed in sectors least affected by the pandemic or more conducive to flexible working arrangements. A 3.3 per cent vacancy rate in Professional services aligns to the relatively high earnings growth seen in Figure 32. The ratio of job vacancies to unemployment or other measures of slack indicates that the labour market has returned to its pre-pandemic level of tightness. While there exist some remaining pools of labour supply, the dynamic

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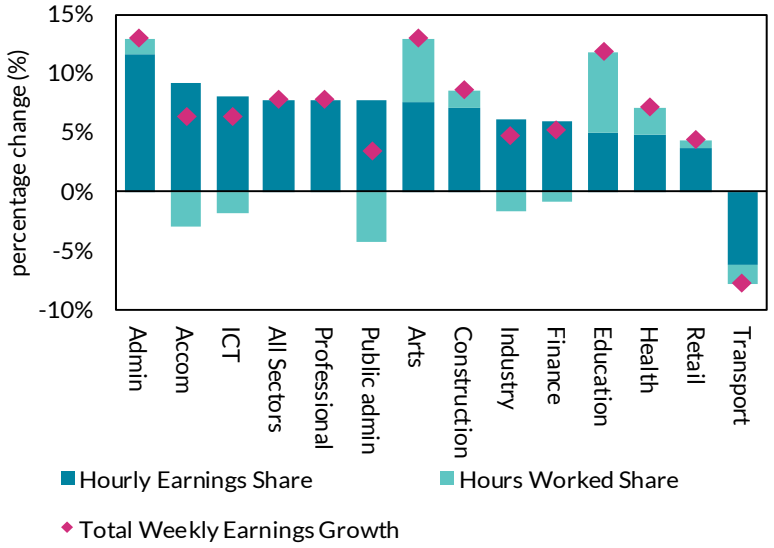
between job vacancies and unemployment will be important for nominal wage growth as bottlenecks persist.

Less adversely affected sectors of sectors have exhibited increased earnings growth with little relative change in contracted hours

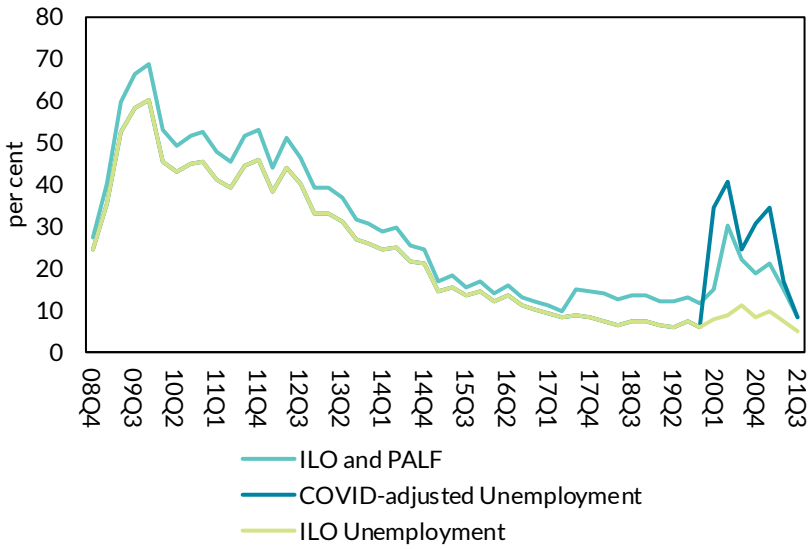
Figure 31: Decomposition of weekly wage growth by average hourly earnings and average contracted hours (Q3 2021 – Q3 2019)



Source: CSO

Labour market tightness indicators have reverted to pre-pandemic levels

Figure 32: Ratio of Labour Slack to Job Vacancies



Source: CSO
Note: PALF refers to the Potential Additional Labour Force. This is the sum of all persons outside of the labour force that are 'Available for work but not seeking' and 'Seeking but not immediately available' and historically exhibit higher transition rate to employment compared to other cohorts outside of the labour force.

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Data from job postings website Indeed show a slight moderation in the growth of labour demand throughout December and into January amidst rising Omicron cases and tightening restrictions. Levels for early-January 2021 measured 43 per cent above the pre-pandemic period of February 2020.31 The weakening in job post levels is attributed to contact-intensive sectors experiencing activity disruptions while labour demand continues to grow in logistics and health sectors. EU business and consumer survey data for Ireland in recent months have continually pointed to labour constraints as a factor likely to limit production over the short-term horizon in both industry and services sectors.[32]

Table 3: Labour Market Projections

	2020	2021f	2022f	2023f	2024f
Employment (000s)	2,253	2,376	2,450	2,501	2,544
% Change	-2.8	5.5	3.1	2.1	1.7
Labour Force (000s)	2,392	2,537	2,601	2,641	2,674
% Change	-1.9	6.1	2.5	1.5	1.3
Participation Rate (% of Working Age Population)	60.2	63.0	63.9	64.2	64.3
Unemployment (000s)	139	160	151	140	130
Unemployment Rate (% of Labour Force)	5.8	6.3	5.8	5.3	4.9
Covid-Adjusted Unemployment Rate (% of Labour Force)	21.1	14.7	6.1	5.3	4.9

Source: CSO and Central Bank of Ireland

Box G: Recent Developments in the Irish Labour Market

By Laura Boyd, Enda Keenan and Tara McIndoe-Calder[33]

Strong employment growth observed in both Q2 and Q3 2021 has seen aggregate levels markedly increase above pre-pandemic peaks. The scale of these unexpected employment increases poses a question as to whether this is due to technical changes arising from new data regulations, transitory pandemic-related issues, a permanent structural shift in the Irish labour market or a

[31] Indeed (2022) "Irish Job Postings Through 7 January: Slowdown"
[32] See Business and consumer survey results for December 2021. Subsector data by country available here.
[33] Irish Economic Analysis Division.

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combination of these factors. This Box explores gender, age and sectoral employment trends in recent quarters and considers how persistent these levels may be as the economy continues to recover from pandemic.

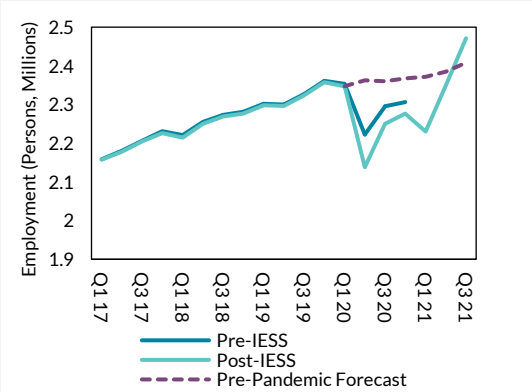
Recent Developments

In January 2021, new IESS regulations were implemented for the Labour Force Survey, with the main changes concentrated on greater testing of employment attachment for persons identified as *Away from Work*.[34] These changes were applied retrospectively to the historical series with minimal effects to the data up to 2019; however a clear *downward* revision was made to employment and labour force participation throughout 2020. This was due to pandemic-related disruptions to economic activity and more persons *Away from Work* classified as inactive rather than employed, which in turn lowered measures such as the Labour Force Participation Rate (LFPR) as a result.

Observing trends in Q2 and Q3 2021 relative to the pre-pandemic period, there has been a sizeable upward swing in employment in the opposite direction of the previous IESS effects. This increase has resulted in the employment profile marginally exceeding, but remaining broadly in line with, *Quarterly Bulletin* projection figures published prior to the onset of the pandemic (See Figure 1).

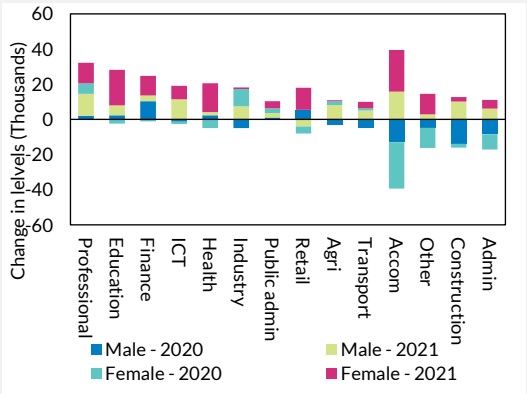
Employment broadly returns to pre-pandemic forecast levels driven mainly by increased participation effect of females across a number of sectors

Figure 1: IESS effect on employment levels



Source: CSO and Central Bank Quarterly Bulletin

Figure 2: Annual change in sectoral employment levels by year)



Source: CSO

[34] See CSO Technical Note "Implications of the Implementation of the Integration of European Social Statistics (IESS) Framework Regulation on Labour Market Statistics in Ireland in 2021" for further details.

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Recent employment increases have been driven by both women and younger age cohorts. Female employment has grown in sectors less adversely-affected by Covid-19 such as Professional services and Education (See Figure 2). These roles are primarily full-time, higher-skilled and salaried positions. These factors may reduce the possibility of the gains being related to transitory pandemic effects. The relative contributions to employment growth since Q3 2019 show disproportionate gains for women (61 per cent), tertiary educated (89 per cent), those working 35+ hours per week (61 per cent) and professional occupations (22 per cent). These developments appear to be largely consistent with recent trends in wages and vacancies data indicating labour market tightness in a number of non-pandemic related and externally-orientated sectors and those which displayed relatively high wage growth prior to the pandemic.

Younger age cohorts (aged 15-19 years) exhibited a greater flow to part-time employment in contact-intensive sectors such as Retail and Accommodation and Food services (See Figure 3). Overall, this group contributed 49 per cent of total part-time employment gains relative to Q3 2019 despite only accounting for a 27 per cent relative increase in total employment. Much of this recent increase may be third-level students utilising non-term periods and term-time flexibility (offered by Covid-related alterations to teaching methods) to occupy roles left vacant by the reduced level of net inward migration due to international travel restrictions. Figure 4 below shows labour force participation for this cohort increasing above its pre-pandemic average to a new high of 36 per cent. Given similar age and sectoral trends in income-support scheme data, it is likely that much of this new employment is supported by the EWSS. The long-term viability of these jobs remains to be seen as supports are tapered and firms begin to realise full wage costs.

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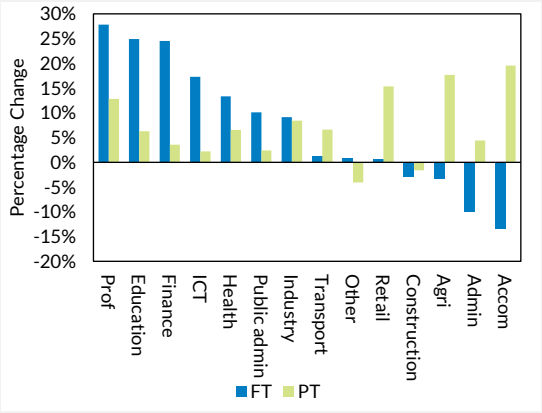
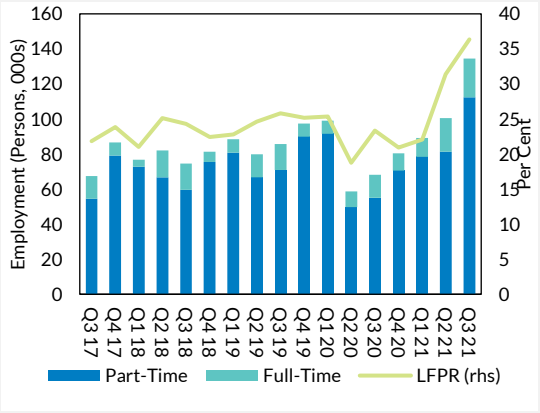
Full-time employment gains in remote working sectors and increased part-time employment in contact-intensive sectors

Figure 3: Relative sectoral contribution to full-time and part-time employment growth (Q3 2021 – Q3 2019)



Source: CSO

Figure 4: Change in third-level student employment and labour force participation



Source: CSO

International Comparison

International comparison shows that several other European countries have also experienced high employment growth in recent quarters (See Figure 5). For example, the employment rate for those aged 15-64 in France reached an all-time high (67.5 per cent) in Q3 2021 and occurred on the back of strong Q2 data.[35] As the unemployment rate remained largely unchanged, France's National Institute of Statistics and Economic Studies attributes the quarterly increase to workforce growth, particularly amongst young people (aged 15-24) whose employment rate rose 2.9 percentage points (primarily due to work-study contracts). The share of young people in France neither in employment nor in education or training is now at its lowest level since 2008.[36] The Netherlands also saw a large employment increase in Q3 2021. Here, however, the rise is also associated with a steep decline in unemployment due to increased job matching. While participation in the Netherlands is at its highest level based on the current measurement method, growth in participation has not been as substantial as in

[35] Note: France continues to test for job attachment of employed persons on temporary lay-off under the pre-IESS situation. Spain also continues to use this method. It is therefore possible a different trend will be observed once full implementation of IESS is completed.

[36] See INSEE Informations Rapides No. 295 for further details.

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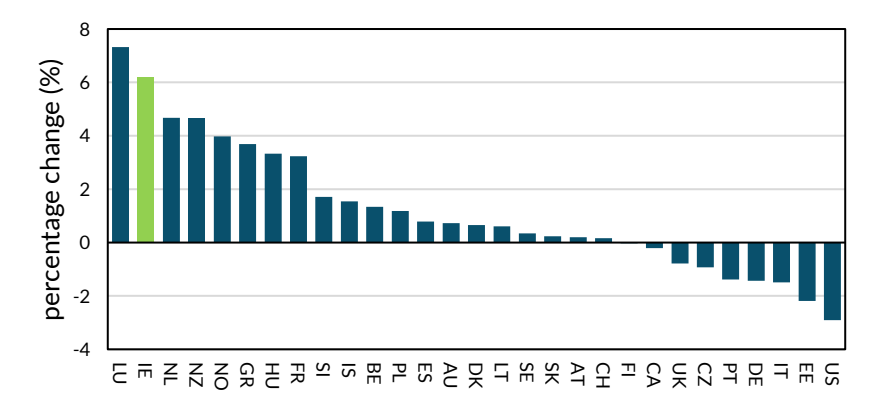
Ireland. The official Dutch unemployment rate in November is now the lowest it has been since the current measurement method was introduced in 2003.[37]

However, other large economies have yet to return to their pre-pandemic levels of employment. These include Germany, where employment levels remained unchanged between 2020 and 2021.[38] In the case of the UK, employment did increase between August and October 2021 (a period that covered the end of the Coronavirus Job Retention Scheme) but the return to pre-pandemic levels is slow, producing labour market tightness.[39] ECB analysis observes a similar but more pronounced situation in the US where labour demand significantly outstrips supply. [40] The '*Great Resignation*', which has seen a higher degree of job switching and re-evaluation of engagement with the labour market, is likely supported by temporarily boosted unemployment benefits, a preference for early retirement, and increased caring responsibilities (particularly for women).

Figure 5: Change in employed population aged 15+ since pre-pandemic (2021 Q3 – 2019 Q3)



Source: OECD and author's calculations

In Europe, increased labour force participation appears to be a key contributor to the observed employment growth. For the first time in the Netherlands, more than 70 per cent of 15 to 74 year-olds are in paid work. [41] The activity rate for France's population aged 15-64 years stood at its highest ever level since ILO definitions were first introduced. [42] LFPR also increased during Q3 2021 in Spain, Italy, and Switzerland and in the case of female labour participation specifically, the majority of countries in Europe observed an increase, both this quarter and compared to before the pandemic (See Figure 6). While Ireland's rate stands out

[37] See CBS News Release "Unemployment Falling Further". Note: from 2022 onwards, the CBS will publish labour force figures based on a new measurement method. It is anticipated that this will identify more unemployed people.
[38] See Federal Statistical Office of Germany Press Release No. 1
[39] See ONS "Latest Employment in the UK" Release
[40] See ECB Economic Bulletin
[41] See CBS News Release above.
[42] See INSEE source above.

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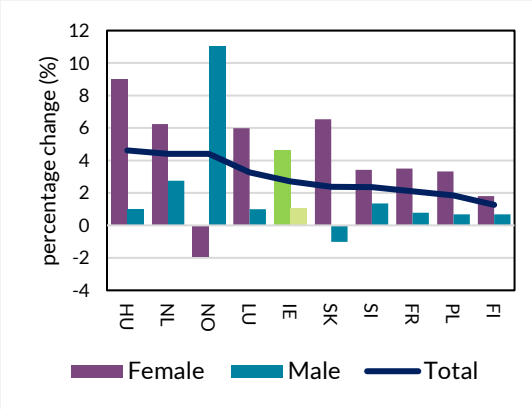
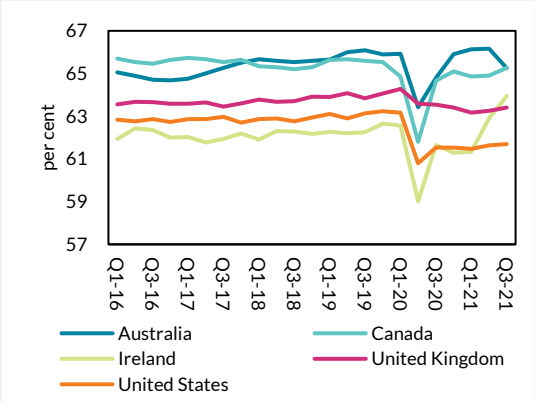
for its magnitude in recent quarters, it is difficult to say if this trend will continue. Other OECD countries, such as Australia, saw a gradual rise in LFPR as part of its post-pandemic recovery only for it to drop in Q3. Evidence from the UK suggests reduced migration flows constrain LFPR growth, while countries such as the US continue to exhibit LFPR well below pre-pandemic levels (See Figure 7).

Figure 6: Top 10 EU countries for change in LFPR of 15+ population compared to pre-pandemic (Q3 2021 vs Q3 2019)



Source: OECD and author's calculations

Figure 7: Labour Force Participation Rates of 15+ population



Source: OECD and author's calculations

Note: Due to methodological differences, OECD data can differ from official figures but it is used for consistency.

The increased participation rates in Ireland, and across Europe, may be indicative of falling barriers to employment, possibly due to greater availability of flexible working arrangements, increased home working or a range of other factors. As yet, it is too early to say what the exact mechanism might be. Further work is needed to investigate these trends in more detail to understand what is driving the remarkable growth in employment and whether it indicates structural change to the labour market.

Conclusion

Ireland has experienced exceptional employment growth for two consecutive quarters. At present, there appears to be a confluence of factors that may have contributed to the recent changes in employment across various demographic groups, such as women and younger workers. While encouraging, it is as yet unclear how much of this change will persist. These recent developments are also evident in several EU countries such as France and the Netherlands. The experience in other countries differs, potentially due to the type of job retention schemes used during the pandemic or their relative starting positions prior to the pandemic. These trends provide a need to monitor developments closely as both pandemic-effects lessen and economic sectors adjust to new ways of working. Further work is planned to explore these developments in more depth.

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Box H: The Carbon Intensity of Employment in Ireland

By Thomas Conefrey, Enda Keenan and Tara McIndoe-Calder[43]

This Box identifies recent trends in the carbon intensity of employment in Ireland in the context of the 2030 carbon reduction targets. Across the EU, greenhouse gas (GHG) emission levels have declined since 2008 even though employment has continued to grow.[44] In Ireland, the pace of decline in emissions has been slower than the EU-average over this period, which has seen the country become the EU's 5th most carbon intensive economy in 2019, moving from 8th position in 2008. Two sectors – Agriculture and Energy and Utilities – make up around two-thirds of non-household sectoral emissions in Ireland, while accounting for a relatively small proportion of employment. For emissions to be reduced while maintaining a given level of activity and employment in a sector, other factor inputs and technology will have to adjust and changes in the composition of output may be needed. The transition to a less-carbon intensive economy will also likely see growth in new sectors and products, with related opportunities for employment growth.

Emission Levels

In order to counteract and lessen the damaging effects of climate change, Ireland has committed to reducing GHG emissions by 51 per cent between 2018 and 2030 and achieve net-zero emissions by 2050.[45] Air emissions data collected by the Environmental Protection Agency and published by the CSO show that total Irish GHG emissions declined by 13 per cent between 2008 and 2019 to 58.7 million tonnes of CO_2 equivalent.[46] Non-household NACE sector activity accounts for an average of 78 per cent of emissions over the period, with household activities comprising the remainder (see Figure 1). Overall, non-household NACE sector emissions have declined by 11.2 per cent. This masks considerable variation between sectors with reductions in the Energy and Utilities and Manufacturing sectors being partially offset by increases in

[43] Irish Economic Analysis Division.
[44] GHG emissions refer to the sum of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_20) and fluorinated gases and are measured in CO_2 tonne equivalents. See EPA for further details
[45] Climate Action Plan 2021
[46] National air emissions accounts are adjusted for non-territorial activities to calculate a territorial emission level that is then measured against national emission targets. This adjustment is calculated by removing transport sector emissions from non-resident units in Ireland and adding Irish resident units abroad. See CSO release for further details. A similar treatment is applied to all EU countries to allow for cross-comparison of emission levels.

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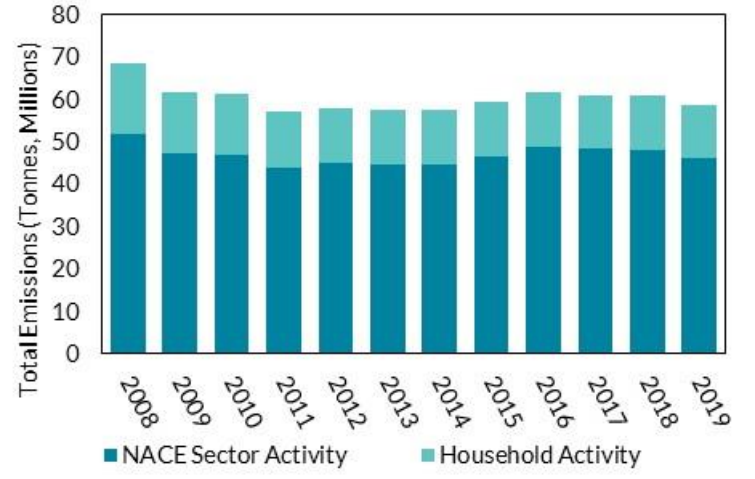
emissions in Agriculture. Households have exhibited a relatively greater rate of decline (23.2 per cent) due to a number of factors such as improved building standards and greater energy efficiency.

Figure1: Irish Greenhouse Gas Emissions (2008 – 2019)



Source: CSO, Eurostat and author's calculations
Notes: Emission levels refer to territorial emissions only

The carbon intensity of employment refers to the ratio between a country's non-household NACE sector emissions and total employment levels as expressed in CO_2 tonne equivalents, hereafter referred to as carbon intensity. Figure 2 shows the level of carbon intensity across the EU-27 as well as the change in carbon intensity between 2008 and 2019. In all countries with the exception of Latvia, the level of carbon intensity declined in recent decades. For the aggregate EU, NACE sector emissions declined by 20 per cent, while employment increased by 3.5 per cent. This decrease can be attributed to a number of factors including the shift towards to service sector-led employment growth as well as gains in energy and resource efficiency (ILO, 2018). In Ireland, carbon intensity fell by 3 tonnes per employment to 19.9 tonnes between 2008 and 2019 (see Figure 2). Within the aggregate EU area, 19 countries reduced their carbon intensity levels to a greater extent than in Ireland. As shown in Figure 3, Ireland's annual average employment growth from 2008-2019 was above the EU-27 average (5.6 per cent versus 3.5 per cent) but the country also recorded the fourth smallest decline in emissions and significantly below the EU average. These developments explain the change in Ireland's position from 8th most carbon intensive economy in the EU in 2008 to 5th in 2019 (Figure 2).

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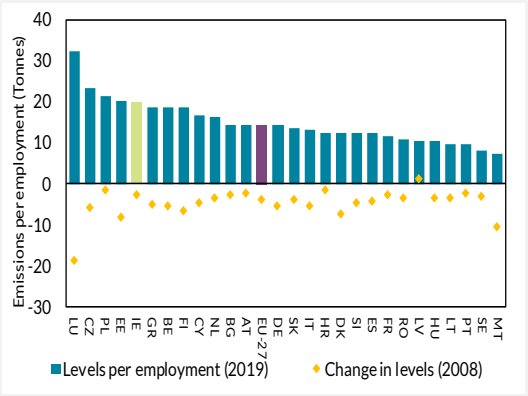
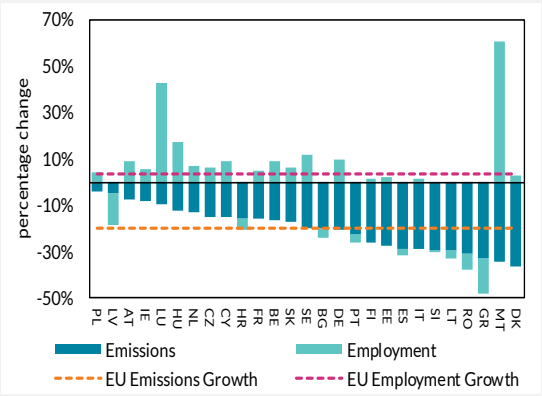
Figure 2: Carbon Intensity of Employment[47]



Source: CSO, Eurostat and author's calculations

Figure 3: Changes in NACE Sector Emissions and Employment (2008 – 2019)



Source: CSO, Eurostat and author's calculations

Compared to other EU countries, Ireland has a smaller share of employment in some energy-intensive industries such as manufacturing and energy but a significantly higher proportion of emissions linked to the agriculture sector (See Table 1).[48] Looking at overall non-household NACE sector emissions, agriculture is the largest sectoral emitter in the Irish economy (44.5 per cent) followed by Energy and Utilities (22.4 per cent) and Manufacturing (16.2 per cent).[49] Agriculture in Ireland is carbon intensive relative to the EU average primarily due to the scale of livestock farming practiced here compared to other countries where arable farming plays a greater role.[50] The large share of agriculture in overall NACE sector emissions in Ireland, combined with the increase in emissions in this sector over time, is a key factor explaining the overall carbon intensity of the Irish economy and Ireland's relative position in an EU context.[51]

The Energy and Utilities sector accounts for a high share of emissions due to the use of fossil fuels in electricity generation, although the use of peat in electricity production has been phased out at end-2020.[52] It is planned to increase the

[47] Luxembourg (LU) emission levels and carbon intensity measurements are likely to be distorted due to the high proportion of the country's workforce that resides in neighbouring countries.
[48] European Parliament (2021) "Climate Action in Ireland: Latest state of play"
[49] If household emissions levels were also included, agriculture would account for approximately one-third per cent of total economy-wide GHG emissions.
[50] See CCAC (2021) Annual Review 2021
[51] As well as in Ireland, the agriculture share of non-household emissions has increased across a number of other EU countries between 2008 and 2019.
[52] In 2020, coal and peat accounted for 21 per cent of carbon emissions from electricity generation, despite only accounting for 5 per cent of actual electricity generation. This results in the carbon intensity of Irish electricity being one of the

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proportion of renewable electricity close to 80 per cent by 2030 from the current level of 42 per cent.[53] The sectors with the lowest carbon intensity are Financial and Real Estate activities and Professional services, which are primarily office-based, non-energy intensive and have increased their share of overall employment since 2008.

Table 1: Sectoral Emission and Economic Statistics (2019)

Sector	% of Emissions	% of Employment	% of GVA	Carbon Intensity Level
Agriculture	44.5	4.7	1.1	186.3
Energy and Utilities	22.4	1.1	1.4	393.6
Manufacturing	16.2	10.9	34	29.4
Transport	6.9	4.6	2.1	30.3
Retail	2.6	13.1	7.5	3.9
Public Admin	1.5	4.9	2.8	6.1
Construction	1.1	6.3	2.5	3.3
Health	1	12.5	4.7	1.6
Accommodation	0.9	7.7	1.7	2.3
Education	0.6	7.9	2.9	1.6
Admin	0.5	4.8	7.1	2
ICT	0.5	5.3	15.4	1.8
Professional	0.5	5.9	4.5	1.5
Other services	0.4	2.5	0.9	3.5
Arts	0.2	2.3	0.5	2.3
Finance and Real Estate	0.2	4.9	10.8	0.8

Source: CSO, Eurostat and author's calculations

Notes: Carbon intensity level is GHG emissions in tonnes of CO2 equivalents divided by total employment.

Conclusion

Despite steps taken over the last decade to lower emission levels such as through increased use of renewable energy sources, improved use of technological innovations in various sectors and some retrofitting of the building stock, the carbon intensity of employment in Ireland remains relatively high in EU terms. Starting from this elevated position highlights the scale of the challenge faced by many sectors in meeting Ireland's 2030 climate targets. For carbon intensive sectors such as agriculture, significant action will be required that delivers a

highest in the EU despite the progress in using renewable energy. See EPA (2020) for further details

[53] See SEAI (2021) Energy in Ireland

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transition to low-emissions farming and land use, along with investment in new technologies.[54]

The Public Finances

The General Government Balance (GGB) appears to have recorded a much bigger improvement in 2021 than was anticipated at the time of the last *Bulletin*. The deficit is estimated to have declined by around €10bn in nominal terms, or from -8.8 per cent of GNI* in 2020 to -3.7 per cent of GNI* last year. This was driven by a sharp recovery in revenues, projected to increase by 14.6 per cent from the preceding year. Tax receipts surprised on the upside throughout 2021, and especially in the final quarter, ending the year €6.5bn or 10 per cent ahead of Budget 2022 profile. Developments in direct taxes were particularly strong, with income tax and corporation tax receipts 4.8 and 27.1 per cent ahead of their annual profiles at year-end, respectively. As a result, corporation taxes are now broadly in line with VAT as the State's second biggest tax head. Social contributions also appear to have rebounded from last year's decline against the backdrop of strong employment growth, with other revenues – sales, capital revenue and other current receipts – broadly stable. Government expenditure is estimated to have increased by a lower-than-expected 2.2 per cent, with gross spending in all Ministerial Vote Groups ending the year below profile. Current Exchequer spending ended the year 1 per cent below expectations, led by underspending in Health and Social Protection, while capital Exchequer spending was 5.5 per cent below profile. Following the Government's decision to extend the key income support schemes, pandemic-related spending is estimated to have cost €13.4bn this year, down from €14.8bn in 2020 (6 and 7 per cent of GNI* respectively). Spending growth was, accordingly, driven by the large increase in permanent or 'core' expenditure announced as part of Budget 2021.

The public finances are projected to continue to improve over the medium term, as strong economic activity drives ongoing revenue growth and COVID-19 related expenditure ends. The GGB is expected to run a deficit of 1.5 per cent of GNI* this year before returning to surplus in 2023. The latter is noteworthy given the scale of the deterioration in the

[54] See CCAC (2021) Annual Review 2021

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budget balance that took place following the emergence of the pandemic in 2020.

The General Government Debt (GGD) ratio is estimated to have fallen to 102 per cent of GNI* last year, with the negative impact of the primary deficit more than offset by the favourable combination of low interest rates and strong economic growth. Favourable debt dynamics are expected to lead to further improvements over the medium term (Figure 33), with the ratio projected to fall to below its pre-Covid level this year before declining to 84.9 per cent by 2024. This represents a significant revision from the previous *Bulletin*, primarily reflecting the quicker return to a primary surplus. Irish sovereign borrowing rates remain at low levels - supported by the ECB's Pandemic Emergency Purchase Programme (PEPP) – while the medium term maturity profile is favourable. The National Treasury Management Agency (NTMA) continues to hold large cash balances, assisting sovereign funding flexibility.

As noted in previous *Bulletins*, there is a high level of uncertainty surrounding the fiscal outlook at present, but that uncertainty has reduced somewhat. In particular, uncertainties directly linked to the pandemic, such as the final cost of support measures, remain prominent. Non-pandemic related issues, such as broader government spending pressures and the potential impact of international tax reforms on corporation tax receipts, are also adding complexity to the outlook.

Fiscal Outlook, 2022 to 2024

A significant improvement in the deficit to €3.8bn (-1.5 per cent of GNI*) is projected this year, driven by continued economic recovery and a decline in pandemic related expenditure. Revenue is expected to record a broadly based increase of 6.7 per cent, above its average growth rate in the three years prior to the pandemic. The tax outlook is underpinned by strong growth in consumer spending and a recovering labour market. On the expenditure side, pandemic-related spending is expected to decline to €6.8bn next year (this figure includes an unallocated €2.8bn contingency reserve which we assume is fully utilised). As a result, total expenditure growth is projected to moderate to 1.7 per cent, with a contraction in social benefits and subsidies offset by increases in government consumption and investment. The latter is expected to increase strongly, underpinned by the National Development Plan and supported by Next Generation EU (NGEU) funding. The deficit is now expected to be lower in

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2022 than in Quarterly Bulletin 4 2021, reflecting the strong positive base effect year from the preceding year.

Table 4: Fiscal outlook under a baseline scenario (per cent of GNI* unless otherwise stated)

	2020	2021f	2022f	2023f	2024f
GG Balance (€bn)	-18.4	-8.5	-3.8	3.4	5.0
GG Balance (% GNI*)	-8.8	-3.7	-1.5	1.3	1.8
GG Balance (% GDP)	-4.9	-1.9	-0.8	0.7	0.9
GG Debt (€bn)	217.9	232.0	229.5	232.4	231.2
GG Debt (% GNI*)	104.7	102.1	92.7	89.0	84.9
GG Debt (% GDP)	58.4	52.9	47.3	44.8	41.3

Source: CSO and Central Bank of Ireland Projections

These trends are expected to continue broadly in 2023 and 2024. The GGB is projected to return to surplus next year (€3.4bn or 1.3 per cent of GNI*) before strengthening further the following year. Revenue growth moderates to 5.2 per cent by the end of the projection horizon, with the anticipated negative impact of international tax reforms on corporation tax receipts weighing on total receipts. Consistent with Government expectations, it is assumed this results in a €2bn loss of revenue over the medium term, although as noted by the Irish Fiscal Advisory Council[55], there is upside risk to this outlook over the projection horizon. While the expectation is that the corporate tax base will decline, the anticipated increase in the corporate tax rate may in the short-term outweigh this in determining actual amounts received. On the expenditure side, while almost all of the remaining pandemic-related expenditure is expected to be withdrawn by end-2022, core spending continues to increase over the medium term. This is consistent with the Government's new Medium Term Expenditure Strategy, which incorporates permanent increases in Exchequer spending of 5 per cent per annum.

[55] See Fiscal Assessment Report, December 2021

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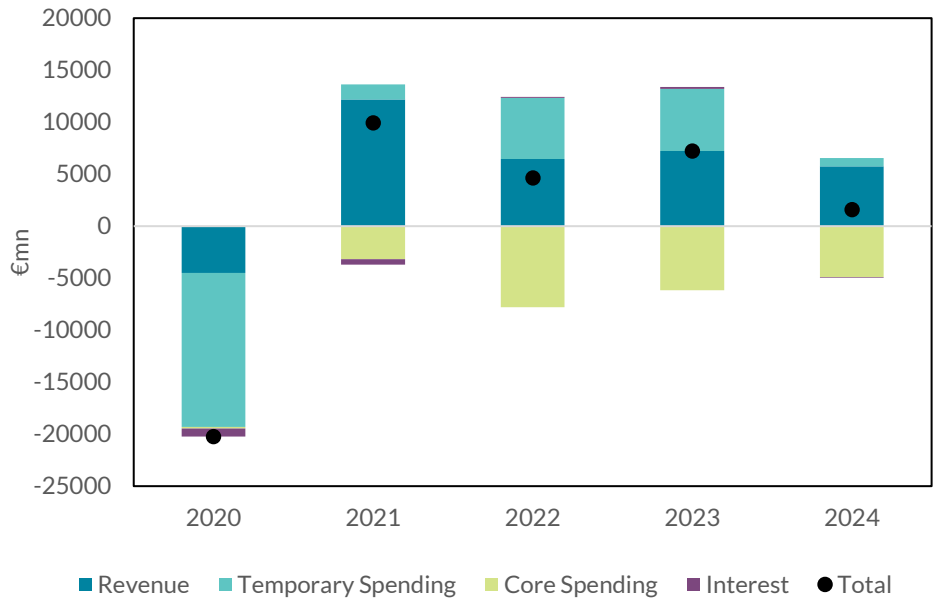
Deficit improves over medium term as pandemic related spending declines

Figure 33: Decomposition of change in Government Deficit



Sources: CSO, Department of Finance, Central Bank of Ireland Projections

In terms of GGD, while the primary budget balance remained in deficit last year, it is estimated that the debt ratio *declined* by 2.6 percentage points to 102.1 per cent of GNI*. This decline reflected the favourable impact of the interest-growth differential, with nominal GNI* growing at a very strong pace and the effective interest rate remaining low (Figure 34). Over the medium term, positive debt dynamics should continue to drive a decline in the ratio, as the interest-growth differential remains favourable and the primary balance returns to surplus. The debt ratio is now projected to fall below its pre-Covid level this year, drop below 90 per cent in 2023 and to decline further to 84.9 per cent of GNI* by end-2024. This would still represent an elevated ratio, with the stock of gross debt approximately €30bn higher at the end of the projection horizon than prior to the pandemic. The National Treasury Management Agency (NTMA) plans to issue €10bn to €14bn of bonds this year, down from the €18.5bn raised in 2021. This reduced borrowing range reflects the improved fiscal position, while the NTMA also held large cash balances - over €27bn - at the end of 2021. This, coupled with Ireland's relatively long maturity debt profile, should provide funding flexibility over the medium term.

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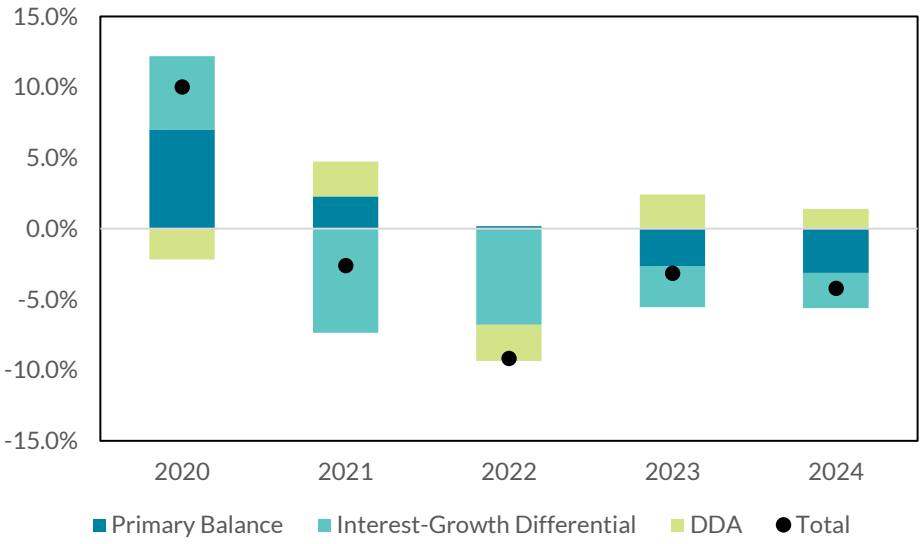
Debt ratio declines over medium term but remains at elevated level

Figure 34: Decomposition of change in Government Debt



Sources: CSO, Department of Finance, Central Bank of Ireland Projections

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Signed Articles

The articles in this section are in the series of signed articles on monetary and general economic topics introduced in the autumn 1969 issue of the Bank's *Bulletin*. Any views expressed in these articles are not necessarily those held by the Bank and are the personal responsibility of the author.

Behavioural Economics and Public Policy-Making

Shane Byrne, Kenneth Devine and Yvonne McCarthy [56]

Abstract

In recent years, insights from behavioural economics have increasingly been used to inform public policymaking. This has been underpinned by an appreciation of the ways in which human decision-making can be influenced by psychological biases and cognitive limitations that have the potential to lead individuals to costly and systematic errors in all facets of life, including in relation to financial products. In response, many public authorities are now seeking to design the instruments of policy to better fit the behavioural realities of the people they are designed to serve, in an effort to remediate adverse consumer and systemic outcomes, and to enhance policy effectiveness. This Article reviews the recent growth in the application of behavioural insights, the ways in which biases can impact decision making, specifically in the financial domain, and why it matters for policymakers, including the Central Bank.

[56] Behavioural Consumer Finance Unit, Statistics Division and Climate Change Unit, respectively. The authors would like to thank Mark Cassidy, Vasileios Madouros, Jenny Osborne-Kinch, Martin O'Brien and Sharon Donnery for their comments. The views expressed here are those of the authors and do not necessarily reflect those of the Central Bank of Ireland or the European System of Central Banks.

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1. Introduction

Recent years have seen an increase in public awareness of the core ideas of behavioural economics and the promise that it offers in both explaining and addressing some of the most difficult challenges in public policy. Reflecting (and driving) this growth has been an increase in the number of public authorities embedding teams within their organisations, dedicated to the application of insights from behavioural economics to help inform and design more effective policies. The benefits have been felt widely, ranging from improved attendance at after-school programmes in South Africa (OECD, 2017), for example, to better designed and more consumer friendly price comparison websites for financial products in the United Kingdom (Smart, 2016), to more recently informing our understanding of the risks posed by COVID-19 and the design of effective policy responses (Lunn et al., 2020).

Underpinning these efforts is the simple but paradigm-shifting idea that people do not always make decisions in a perfectly rational way, weighing up all available information in order to arrive at a decision that maximises their own wellbeing. Instead, we take cognitive shortcuts and follow rules of thumb in order to manage complexity in our everyday lives. While these shortcuts (or 'heuristics') can provide an effective means for navigating the many and varied decisions that confront us each day, they may also lead us into costly and predictable errors, owing to the systematic intrusion of behavioural biases.

While many of these errors may be relatively inconsequential in terms of welfare costs, others can lead to significant and lasting detriment both at the level of the individual and the wider community. It is this latter category of 'behavioural market failures' that have caught the attention of public authorities who have sought to apply simple insights from behavioural economics to remediate their negative effects. At its core, this response has amounted to an effort to design instruments of public policy to better fit the behavioural realities of human decision-making.

In this article, we offer a perspective on how behavioural economics can provide valuable insights for public policy in the financial domain. In Section 2 we introduce the concept of behavioural biases and how they can affect the decision-making process. In Section 3 we explore

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the impact of behavioural biases in the financial domain. We review the rapid growth in the application of behavioural insights that has taken place across diverse public policy settings in Section 4. Section 5 focuses on the research toolkit available to policymakers to identify and remediate behavioural risks. Section 6 concludes.

2. Behavioural biases and decision-making

How does behaviour influence decision-making?

Behavioural biases occur when normal human thought systematically departs from being fully rational in very specific ways. Biases can be unconscious and emotional, causing people to take action based on their feelings instead of the facts. They can cause people to be inconsistent in their choices, for example, changing their minds when the same decision is presented in a different way, or causing people to misjudge important information. In other words, when making decisions, our thought processes can sometimes lead us to make errors, and these errors can be predictable.

Nobel Laureate Daniel Kahneman provides a useful conceptual framework for thinking about how behavioural biases can arise (Kahneman, 2011). He draws attention to the dichotomy between the brain's fast, instinctive, and emotional processor (referred to as System 1), and the slower, more rational, and deliberative mental processor (System 2). Behavioural biases are said to arise from the dominance of System 1 in certain decision-making processes, forcing an individual's decision to deviate from their true underlying preference, often in ways that can be to the detriment of the decision-maker.

Traditional microeconomic models tended to assume that individuals operated in a perfectly rational way, making decisions based on all available information for the purpose of maximising own welfare. A broad body of evidence now shows that people can make mistakes when faced with a decision, not always opting for the welfare maximising option nor the one that meets their own stated preferences. Furthermore, errors can be systematically related to the context in which they are made – implying that individuals who design the context in which options are presented (the" choice architecture") can influence the decisions that people make (Thaler and Sunstein, 2008). Behavioural economics brings a richer

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psychological perspective to economic thinking, helping to understand how and why people make particular decisions. Insights from behavioural economics are thus now widely used to assist public-policy making across a range of policy areas (discussed further in Section 4).

Why does it matter?

Behavioural biases tend to be systematic, which means they can be detectable and predictable. They can cause people to be susceptible to manipulation and influence, in ways which can further undermine a person's welfare (by way of so-called 'negative nudges').[57] For example, several studies find evidence of the framing effect – when our decisions are influenced by the way that information is presented (Kahneman and Tversky, 1979). Similarly, studies show that individuals often stick with default options, even if better alternatives are available. [58]

As well as causing harm at the individual level, behavioural biases can also have consequences for the wider community. An important lesson for post-crisis financial regulation has been the increased recognition that systems can be much more than the sum of their parts (Lautenschläger, 2018). This is true also in the domain of harms arising from behavioural biases. An individual decision making error can carry with it an 'externality', or spillover cost that is not directly incurred by the decision maker. Indeed, Lunn (2014) finds evidence that the roots of the Irish 2008 / 2009 financial crisis were linked, among other things, to behavioural factors whereby the inability of individuals in financial markets to make sound decisions had wider implications on financial stability.

Finally, the presence of behavioural biases can mean that instruments of public policy aimed at informing and engaging consumers may not be as effective in achieving their objectives as they could be, if they do not account for the realities and complexities of human decision-making.

[57] As outlined by Thaler and Sunstein (2008), a nudge is any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives.
[58] Keys et al. (2016) show households can lose out on substantial savings by sticking with existing mortgage products and failing to refinance when interest rates decline.

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3. Behavioural biases in the financial domain

While behavioural biases can affect all types of decisions, their impact in the financial domain can be particularly acute. Modern financial decisions have become increasingly complex, with diverse options to choose from and novel platforms over which to make decisions. In addition to decisions relating to traditional financial products such as savings accounts and mortgages, for example, households today are presented with a growing array of new financial technology, and innovative product options, relating for instance to payment solutions, investment, or retirement planning. For many consumers, these decisions represent 'one-shot' games, where the stakes are high, where choices are typically not revisited after a decision is made, and where the opportunities for adaptive learning from repeated interactions are limited.

At every stage of the financial product life cycle, there is the potential for behavioural obstacles to impair household financial management and to expose consumers, institutions, and the broader financial system to risks. The kind of products we choose, and when we choose them, can be influenced not only by objective suitability but also by behavioural characteristics. These include characteristics like a tendency towards procrastination, so that we push out an action that could be completed today, or by impulsivity, where we sign up to a product on impulse, perhaps without doing a thorough evaluation of its appropriateness for our needs. How and whether we engage with a financial provider or advisor can also be influenced by characteristics such as inertia, short-sightedness, and other psychological barriers as much as by rationality.[59] Similarly, how we manage our financial products after we have chosen them - the way we repay our credit card debt; whether we switch provider; and how we allocate investment portfolios, - for example, are all decisions that are vulnerable to the costly intrusion of behavioural biases. We provide extra detail on five specific types of bias with respect to individual's financial decisions in Table 1, with reference to specific examples from the behavioural economics literature.

[59] Inertia can be defined as the tendency to stick with a previous decision regardless of the outcome. Short-sightedness is an inability to view long term implications, opting to focus on short-term outcomes.

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Table 1: Behavioural biases in the financial domain, select examples

Bias	Description	Financial Product Example
Status Quo	This is the tendency to stick with the status quo, even when doing so may be financially disadvantageous if rationally weighed against alternative options. Consumers may stay in financial situations that are sub-optimal, or even damaging to their welfare, as a result. Status quo bias may apply, for example, when a consumer does not switch away from their current financial provider or product, even if it would be advantageous to do so. Central Bank research by Byrne et al. (2020) shows low switching activity in the Irish mortgage market, despite the significant savings available to consumers if they were to switch[60,61]. The Central Bank's recent review of differential pricing in insurance markets illustrated that loyalty to a provider can be penalised by 'price walking' over time. The study found that a year 9 renewal customer paid, on average, 32 per cent more for home insurance than a year 1 renewal with the same cost of service (Central Bank, 2021). Kempf and Ruenzi (2006) illustrate the presence of status quo bias in the US mutual funds industry. They show how the tendency for individuals to choose a previously selected option increases in line with the number of options available even when it is not the optimal choice (the effect if there are more than 100 alternatives is three times as large as if there are only less than 25 alternatives).	• Switching financial products / providers • Pension auto enrolment
Present Bias	This is when we attach a disproportionate importance to payoffs that occur sooner when compared to those that occur in the future. The design of products such as payday loans can exploit present-biased preferences in borrowers. Research has shown that this form of high-cost borrowing is used despite the availability of cheaper credit (Agarwal et al. 2009). King and Singh (2018) show that present biased consumers are more likely to choose costly cashback mortgages.	• Payday loans • Pension contributions • Savings • Teaser rates
Loss aversion	Loss aversion refers to the tendency to weigh more heavily the cost of a given loss as against the benefit of an equivalent gain. It has been shown to affect decisions in the insurance domain, where, for example, Sydnor (2010) finds a high level of risk aversion to low-level financial loss in the home insurance market. On average, consumers who are only required to pay small amounts toward an insured loss paid five times more in additional premiums than what the actual insurance was worth. Consumer perception of the chance of experiencing financial loss can be biased by rare events, resulting in a willingness to pay a higher premium for the security that insurance provides. Loss aversion also helps to explain the disposition effect, where investors tend to hold on too long to assets that have lost value, reluctant to realise the loss, while having a greater likelihood of selling 'winners' (demonstrated for instance by Weber and Camerer (1998)).	• Insurance Products • Investment Holdings

[60] The research shows that three in every five eligible mortgages stand to save over €1,000 within the first year if they switch, and more than €10,000 over their remaining term.

[61] In limited circumstances, status quo bias can be used to positive effect. Madrian and Shea (2001), for example, showed participation rates in pension plans for newly hired workers in the US increased by 37 per cent when employees were automatically opted-in to pension plans.

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Framing	Framing refers to the act of influencing decisions by the manner in which options are presented. While traditional economic theory assumes consumers are able to process complex financial information, evidence shows that they experience difficulty in assessing the benefits and risks associated with certain products (Barr et al, 2009). As consumers appear to have limited attentiveness with which to review information, the manner in which information is presented can dictate consumer choice. Consumers can be misled, giving institutions a motivation to manipulate this bias by concealing the true cost of a product. One US study showed that credit card companies targeted less-educated customers with letter designs to encourage more back-loaded fees (e.g., lower introductory rates but higher late and over-limit fees) compared with letters sent to better educated customers (Ru and Schoar, 2016). In another context, FCA (2014) show how presenting annuities and other pension pot drawdown strategies under different frames can significantly influence relative preferences for these retirement income products.	• Credit card repayments • Teaser rates • Cashback offers
Overconfidence	This is when the feeling of confidence in our ability or in a particular outcome is excessive relative to our actual ability or the true probability of outcome occurrence. It can emerge when estimating the probability of positive outcomes taking place and the ability to deliver the correct outcome across challenging decisions. This can be observed in stock investment behaviour when traders attribute poor performance to being unlucky and good performance to skill. Research shows that individual investors are inclined toward this behavioural bias and as a result make trading mistakes (Chen et al. 2007). This evidence highlights that not only do investors trade too often but they also hold under-diversified portfolios, exposing themselves to market volatility. In a study among Dutch retail investors, Kramer (2016) shows that confidence in one's own financial literacy is negatively associated with asking for financial advice, in a manner that is not related to actual underlying expertise.	• Investment portfolio selection • Financial advice

The examples listed above represent just some of the common behavioural biases that can pose risk within the domain of financial decision-making. The impact of these biases can compound the effect of more traditional impediments such as a lack of transparency, lack of experience, knowledge or financial literacy on the part of a consumer. More broadly, the interaction of these behavioural biases with complex features of financial products can make it difficult to successfully navigate the financial landscape, and easy to incur losses (Lunn et al., 2016). It is clear that, despite advances in the field, further analysis is required to address the predictable behavioural pitfalls that lead consumers systematically into costly errors.

4. Global applications of behavioural insights

Scale and range

Today, the OECD puts at 202 the growing number of institutions around the world that are applying behavioural insights to public

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policy (OECD, 2021).[62] The application has been broad across sectors - as well as its application to financial regulation, lessons from behavioural economics have also been applied to enhance health, education, energy, and environmental policy and outcomes. In addition to this horizontal spread across sectors, behavioural insights are now permeating vertically by their adoption at all levels of public administration, from supranational to local levels of governance. These initiatives have typically involved simple targeted interventions aimed at helping people to overcome identified behavioural obstacles and to avoid predictable and costly decision-making errors.

Behavioural initiatives within government

Reflecting the accumulation of a large body of evidence speaking to the ability of behaviourally-informed policy responses to deliver meaningful impacts in addressing challenges in public policy, more and more government departments and public authorities around the world are embedding their own behavioural units to inform effective policy and deliver better outcomes.

Most notably, the UK Government established the Behavioural Insights Team (BIT) in 2010 with a mandate to make public services more cost-effective and easier for citizens to use, improving outcomes by introducing a more realistic model of human behaviour to policy, enabling people to make 'better choices for themselves' (HM Government, 2010). By the end of 2018, the BIT had run more than 780 projects in dozens of countries (BIT, 2019).

Similarly, in 2015, President Obama used an Executive Order to direct federal agencies to integrate behavioural insights into their programmes, and established the Social and Behavioural Sciences Team (SBST).[63] Within its first year, the SBST had built 12 behaviourally-informed projects to improve existing federal programmes ranging from college access to criminal justice reform (Thaler, 2015; SBST, 2016).

The Behavioural Economics Team of the Australian Government (BETA) was established in 2016 with a mandate to apply and

[62] In 2016, the European Commission undertook a survey of cases across 32 countries in Europe and collected over 200 initiatives where behavioural insights were applied to policymaking.
[63] Executive Order 13707

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rigorously evaluate behavioural insights for public policy and administration. Since its establishment, BETA has completed 16 behavioural trials, worked with more than 30 partners, and delivering an estimated AUS$25 million in direct benefits to the government each year (BETA, 2019).

Similar behavioural insights units are now a normal part of central government and the delivery of public services in many other countries around the world, including, for example, France, Germany, Denmark, the Netherlands, Canada, Singapore, and Peru (Afif et al., 2018).

Behavioural insights have also been applied in the financial regulation domain, with the Financial Conduct Authority (FCA) in the UK at the forefront of delivery (Erta et al, 2013). The FCA has implemented and published results from a range of behaviourally-informed projects designed to test remedies to identified harms arising in regulated product markets, including savings accounts, credit cards, home and car insurance and retirement annuities, for example. Other financial regulators have followed suit, seeing merit in using behavioural economics to help them better discharge their statutory responsibilities. These include the Dutch Authority for Financial Markets (AFM), the Australian Securities and Investments Commission (ASIC), the Italian financial markets regulator (CONSOB), and Spain's National Securities Exchange Commission (CNMV).

The range of noted examples illustrates the broad and successful integration across jurisdictions and mandates of behavioural insights within the ordinary course of public policymaking.

Notable examples in the financial domain

'Save More Tomorrow' represents one such case in the United States, aimed at helping people to overcome problems in self-control, present bias and procrastination, which weigh against adequate financial provisioning for retirement over their working lives. Through this initiative, participants voluntarily pre-commit to incrementally increasing their pension contributions with each future pay rise. The participant experiences no drop in take-home pay today, but a reduction in future take-home pay, which is less acutely felt. While participants are free to opt out, a tendency to stick

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with the default (Status Quo bias) in this case facilitates the automatic fulfilment of the retirement savings plan and the avoidance of ongoing mental effort costs. The core design features of the scheme were incorporated into US law in 2006 as part of the Pension Protection Act. The scheme is estimated to have already helped over 15 million Americans to significantly boost their savings rate.[64]

Regulatory reform in Australia adopted in 2011, similarly sought to apply lessons from behavioural economics to ensure more effective regulation of consumer credit. A series of measures was adopted to assist households to better manage their credit card debt. These included a ban on providers contacting borrowers to offer unsolicited credit limit increases, in an effort to counter self-control problems as well as optimism-bias on the part of the borrower in relation to their capacity to repay extra debt in the future (Ali et al., 2012). Additionally, providers were required to 'unbundle' complex pricing structures designed to attract new customers with temporarily low introductory interest rates, thereby targeting the present bias that may induce borrowers to choose products that represent poor value for money over the longer-term.

Irish applications

In Ireland, behavioural economics has also established a firm footing in the public policymaking process. In 2016, the Irish Government Economic Evaluation Service documented 13 separate behavioural economics projects undertaken by seven government departments in areas ranging from health, social protection, and agriculture, to justice, foreign affairs and revenue (Purcell, 2016). The challenges addressed have included the reduction of non-attendance at group information sessions, closing the completion gap of land registration in Ireland, increasing filings from late income tax returns, and encouraging farmers to meet nitrate emission regulations. Separately, the Economic and Social Research Institute (ESRI) and its dedicated Behavioural Research Unit has been instrumental in driving forward the application of behavioural science to policymaking in Ireland over the past decade. A broad range of techniques have been used across these projects, including, for example, the personalisation and simplification of communications to

[64] http://www.shlomobenartzi.com/save-more-tomorrow

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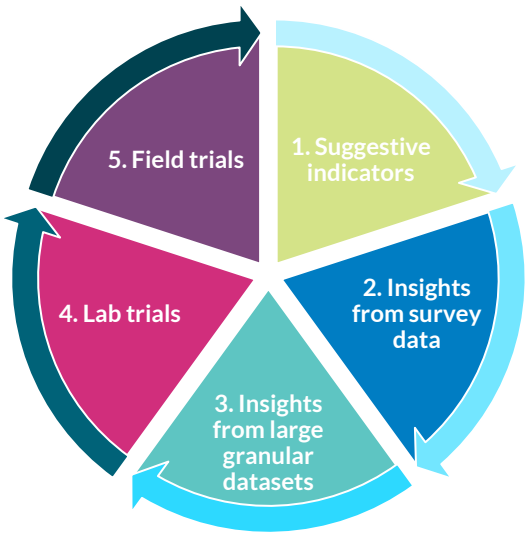
elicit greater consumer engagement, increasing the salience of certain features to draw attention to the most pertinent aspects of a decision, changing the way in which options are framed and the use of reminders.[65]

5. Toolkit for behaviourally-informed policymaking

Policy challenges can stem from a variety of causes, which may interact in complex ways. Policymakers seeking to apply techniques from behavioural economics to address a policy challenge must first isolate the behavioural component of the problem, as distinct from other explanatory factors, insofar as is possible. To do this, and to address, if appropriate, problems that arise from the impact of behavioural biases, policymakers have a range of tools at their disposal. Figure 1 provides an overview.

Figure 1: Toolkit to diagnose and address behavioural effects



In the first instance, the impact of behavioural biases on a particular outcome could be suggested by data points or indicators. These include, for example, cases where consumers report confusion or misunderstanding in relation to products, where they report regret in

[65] For instance, in a trial, which randomly assigned 15 per cent of intended recipients of a mailed survey to a group whose letter contained an additional personalised post-it note, the Office of Revenue Commissioners found that they could lift response rates from 22 per cent to 42 per cent after 35 days (Kennedy, 2013).

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relation to advertised services and realised outcomes, or where consumers exhibit behaviour that is manifestly at odds with common sense, contradictory relative to other choices, or inconsistent over time (Campbell et al, 2011). These factors are not exhaustive, and they do not provide conclusive evidence of the presence of behavioural biases. They are, however, examples of the kinds of observable indicators that could indicate the presence of consumer risks that might warrant closer investigation.

Further, and more targeted, insights can be gathered through household / consumer surveys. A vast array of simple and sophisticated methods now exist for the elicitation of behavioural characteristics by survey. Using these methods, it is possible to associate a tendency to behavioural biases to particular decisions and outcomes. In so doing, surveys can help to confirm the behavioural dimension of an issue as distinct from other contributory factors that may be at work.[66]

The analysis of granular datasets can provide another option for policymakers to locate and diagnose issues that arise in regulated markets from behavioural biases. While not providing the same depth of insight that may be possible through direct surveys, regularised and structured datasets can facilitate consistent monitoring of markets, identification of emergent patterns and problems, and crucially, they can assist in estimating the scale of adverse impacts. In one example, Hastings and Shapiro (2018) combined administrative and transaction-level data from a large grocery retailer to observe evidence of mental accounting among recipients of nutritional benefit vouchers in Rhode Island – the behavioural phenomenon whereby people treat money differently depending on its origin and intended use, rather than thinking of it as fungible. Mental accounting also helps to explain why people exhibit a greater willingness to pay for products and services when payment is by credit card rather than by cash (Prelec and Simester, 2001), or the 'co-holding puzzle', whereby individuals neglect to pay off high-interest credit card debt while simultaneously holding deposits in low-interest yielding savings accounts (Gathergood and Weber, 2014).

[66] For a useful review of survey-based elicitation of 17 behavioural factors, see Stango et al. (2017).

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However, randomised controlled trials (RCTs) are the most powerful tool at the disposal of policymakers wishing to gain insight into the drivers of individual behaviour, and to obtain reliable evidence in relation to the relative effectiveness of alternative potential policy remedies. RCTs are carried out with a sample of people making decisions in the particular population of interest. They directly test whether proposed remedies actually work, but equally, are the most effective tool to help policy makers understand which interventions do not work.

In RCTs, participants are divided into two or more groups, with one group (the control group) receiving the standard treatment and so acting as an analytical benchmark. The other group (the treatment group) receives a new intervention. The groups are chosen to be similar prior to the intervention so that any observed difference in behaviour after the intervention can be precisely attributed to the intervention being tested. RCTs are thus considered the strongest method to provide causal evidence on how policy interventions will affect consumer behaviour (Haynes et al., 2012).

RCTs can be conducted in the lab (i.e. with volunteering participants in an artificial environment with a controlled set of information and rules), or in the field (i.e. with a sample of participants making decisions in real life). Each format has its own advantages and disadvantages, and which method is preferable will always depend on the particular context and question under evaluation. Lab trials offer the capacity to test specific mechanisms in a controlled, closely observed environment, usually at a smaller scale and more quickly than can be achieved in the field. However, lab trials can be less reliable in terms of their external validity (i.e. providing an evidential basis for what might be observed in a real-world environment). Field trials, by contrast, generally offer the most realistic and robust basis to evaluate how a proposed intervention actually works in the real world, but typically require a greater investment of resources, and as such, may not always be the most suitable tool to apply in a given circumstance.

Behaviourally-informed trials can be used to pre-test policy options, essentially producing evidence on the likely impact of a policy prior to its roll-out. Of 159 OECD surveyed cases where behavioural insights were applied to policymaking, well over half involved an

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RCT, pilot test, laboratory experiment, or online experiment (OECD, 2017). Of the over 780 behaviourally-informed projects run to date by the Behavioural Insights Team, 400 have involved an RCT (BIT, 2019). This method of pre-testing allows policymakers to first obtain empirical evidence to demonstrate whether a 'positive nudge' intervention is likely to be effective before rolling it out for the target population at large, and also to understand what precise version might be most effective.

One powerful example that demonstrates how pre-testing of policy solutions using an RCT can be particularly fruitful comes from the FCA. The FCA sought to identify the most effective means of encouraging customers to seek redress for mis-sold financial products. Working with a firm that was writing to 200,000 customers inviting customers to claim redress, the FCA designed seven amendments to the standard customer letter. These amendments included an urgency message (urging recipients to 'act quickly'), reducing the amount of text by 40 per cent, using salient bullet points for key information, and the issuance of a reminder. Results of the trial found that the most effective approach involved combining salient bullet points with a reminder, increasing response rates by 800 per cent relative to the control group (equivalent to an additional 20,000 customers claiming redress due). This exercise provided valuable insights to the FCA in stipulating the shape of future redress schemes, to more effectively vindicate the interests of consumers (Adams et al, 2013; OECD, 2017).

Conclusion

It is now widely recognised that human behaviour deviates frequently and systematically from an assumed rational state. Far from the traditional depiction of fully rational utility maximisation, our decision-making can be driven equally by emotional and psychological factors, features of our choice environment and cognitive shortcuts. While these influences are not necessarily wholly negative, in some settings they can lead us into systematic and costly errors.

Since the influence of behavioural biases is systematic, their impact can also be predictable, and because of the helpful insights available from the large and growing literature on behavioural economics, they

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can also be remediable. This recognition has prompted an increasing number of public authorities to incorporate the lessons of behavioural economics for more effective policymaking. These applications support the principle of evidence-based policymaking, but more importantly, reflect the reality of human decision-making in the public policy sphere.

In the financial domain, behavioural insights offer great potential to give a richer understanding of how people navigate an increasingly complex product landscape. The Central Bank has recently published its new Strategy document outlining the core strategic theme of being a future-focused organisation[67]. Insights from behavioural economics can be used to advance our capabilities in analysis and research on economic and financial issues through innovation in our ways of working. To this end, the Central Bank has established a small team, dedicated to the uses of behavioural economic insights and techniques to better understand how and why people make financial choices, with a clear focus on the role of behavioural factors. Initial work by the team has explored mortgage switching (Byrne et al, 2020) and differential pricing (Byrne and McCarthy, 2020). Looking forward, the unit will focus on selected areas, and where appropriate, use the latest techniques available within the behavioural toolkit to help provide evidence for effective policy design while complementing other analytical approaches.

[67] https://www.centralbank.ie/docs/default-source/publications/corporate-reports/strategic-plan/our-strategy/central-bank-of-ireland-our-strategy.pdf?sfvrsn=4

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The Macroeconomic Implications of Climate Change for Central Banks

Niall McInerney[68]

Abstract

Climate change is one of the most significant issues affecting the global economy. As a small open economy, Ireland is particularly vulnerable to economic spillovers from the international impact of climate-related risks. In recognition of the potential of these risks to affect their ability to maintain both price and financial stability, many central banks, including the Central Bank of Ireland, have started to embed these risks in their analytical and modelling frameworks. In this *Article*, we explore the key challenges presented by climate change for central banks. We first examine the economic implications of the risks associated with continuing climate change and abrupt mitigatory actions. We then review how these risks could affect the transmission of monetary policy through conventional channels. Finally, we discuss how the Central Bank's analytical framework needs to adapt and suggest that a suite-of-models approach offers the most practical and effective way of addressing these issues.

[68] Irish Economic Analysis Division. The views expressed in this article are solely the views of the author and are not necessarily those held by the Central Bank of Ireland or the European System of Central Banks. The author would like to thank James Carroll, Mark Cassidy, Thomas Conefrey, Sharon Donnery, Neil Lawton, Martin O'Brien, Gerard O'Reilly and Gillian Phelan for helpful comments.

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1. Introduction

Climate change is one of the most significant structural forces affecting the global economy (Lane, 2019). In particular, meeting the goals set by the Paris Agreement, and the associated requirement of achieving net zero emissions, will necessitate a deep, and in some cases disruptive, shift in production processes and consumer preferences away from carbon-intensive goods and production methods towards more sustainable alternatives. At the same time, the rising frequency and severity of extreme weather events raises uncertainty about the future distribution of economic shocks hitting the economy.

The economic analysis of the potential impact of climate change focuses on two types of risks: 'physical' and 'transition'. Physical risks relate to economic costs and financial losses that stem from higher temperatures and more frequent and extreme climate events (BCBS, 2021).[69] In terms of long-term warming, the global average near surface temperature has risen by over 1.1°C relative to pre-industrial levels and the continued anthropogenic emissions of greenhouse gases (GHGs) are projected to lead to further increases in temperature over the next century (Kaufman et al, 2020).

The ongoing rise in average temperatures will likely lead to more regular occurrences of heavy precipitation, higher sea levels, and potentially more severe Atlantic storms that could generate storm surges and extreme waves (IPCC, 2014).[70] These events could significantly increase flooding risks in countries like Ireland and thereby raise the economic costs of climate change by damaging property and infrastructure.[71] Figure 1 shows that the cost of flooding and other extreme climate-related events over that last four decades has been sizeable across the euro area. In the case of Ireland, the cumulative costs are close to 2.3 per cent of modified GNI.

To mitigate global warming and reduce the severity of the impact of climate change, economies need to transition to a low-carbon economy by reducing GHG emissions (IPCC, 2014). However, addressing the risks from

[69] These include tropical cyclones and hurricanes, extra tropical cyclones, convective phenomena such as tornadoes and severe thunderstorms , mesoscale phenomena such as polar lows, floods, drought, and heatwaves (Stephenson, 2008).
[70] For example, Met Eireann projects that the frequency of heavy precipitation events during autumn and winter months in Ireland could rise by 20 per cent (Nolan et al, 2017).
[71] These economic costs are in addition to the harm to human health and well-being, cultural heritage, and the environment that is caused by these events.

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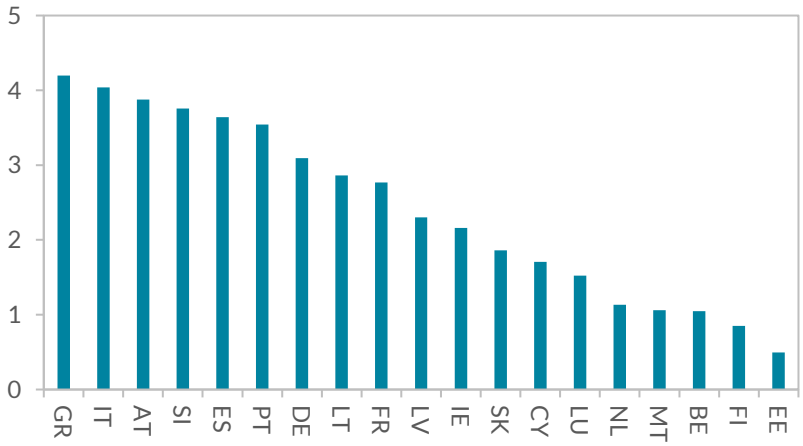
climate change is particularly challenging due to the so called "tragedy of the horizon" which posits that while mitigation policies may lead to output losses in the medium term, the benefits accrue over the longer term due to the avoidance of much greater damage from climate change over that longer horizon (Carney, 2015). The long term nature of these risks differs from the typical planning and risk management horizons of consumers, firms, governments and policy organisations. Accordingly, as climate-related risks have a different frequency and temporal distribution compared to other types of macroeconomic and financial risks, tackling these risks from a policy perspective requires concerted effort and leadership (Lane, 2019).

Figure 1: Cumulative GDP losses due to extreme weather and climate-related events 1980-2019 (% of 2019 GDP)



Source: European Environment Agency, AMECO, Drudi et al (2021)
Notes: Losses for Ireland are calculated in terms of modified GNI (GNI*).

In response to the risks posed by climate change, countries representing 70 per cent of global emissions and GDP have set targets for net zero emissions by 2060 at the latest (IEA, 2021). Both the European Commission and Irish government have announced plans to reach net zero emissions by 2050. These plans include policy measures that will increase the price of carbon, stimulate innovation and enhance the energy efficiency of firms and households. However, the process of adjustment towards a low-carbon economy can give rise to certain risks ('transition risks'). Several factors could slow or disrupt the transition, and adversely affect the economy and financial system (BCBS, 2021). For example, abrupt or uncoordinated carbon pricing policies could lead to large cost increases for carbon-intensive firms and to a sharp depreciation of assets values of firms in carbon-intensive sectors. The resulting fall in the

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collateral values of these 'stranded' (or unusable) assets could significantly reduce investment and generate financial stability concerns. Risks may also arise from unanticipated technological breakthroughs that lead to structural shifts in production processes and render carbon-intensive technologies obsolete. Finally, short-term transition risks can stem from sudden changes in the expectations of consumers, firms or financial markets about future policies or technologies, which can lead to a spike in risk premia for firms in the affected sectors (Vermeulen et al, 2018).

There is therefore considerable heterogeneity in the exposure of sectors to transition risks.[72] Table 1 illustrates this heterogeneity for Ireland. It shows that Irish emissions, whether in terms of all GHGs or just CO_2, are mainly driven by a small number of sectors including agriculture, electricity and manufacturing.[73] With the exception of manufacturing, these sectors also represent a relatively small share of total gross value added.

Table 1: Irish Sectoral Emissions and Energy Intensities in 2018

Sector	GVA Share (%)	GHG Share (%)[74]	CO_2 Share (%)	GHG Intensity (Kg/€)	CO_2 Intensity (Kg/€)	Energy Intensity (%)
Agriculture, forestry, and fishing	1	43.1	4.8	7.2	0.4	18.7
Transportation and Storage	2.1	6.8	12.3	0.5	0.5	52.1
Electricity, gas, steam, air con. Supply	1.1	19.9	35.3	3.1	3.0	53.9
Manufacturing	35.4	16.1	29.1	0.1	0.1	1.5
Water supply, sewerage, waste mgt.	0.4	3.9	3.3	1.5	0.7	12.8
Wholesale and retail trade	7.8	2.5	4.7	0.1	0.1	2.9
All sectors	100	100	100	0.2	0.1	3.2

Source: CSO and own calculations

[72] While this analysis focuses on sectoral vulnerabilities, there is also substantial heterogeneity in exposures to transition risks at the household level. For example, Tovar Reanos and Lynch (2019) show that the share of expenditure on heating and lighting for the lowest quartile income households in Ireland is almost three times that of the highest.

[73] The emissions data are adjusted for non-territorial activities to calculate emissions on a territorial basis. See Conefrey et al (2022) for further details.

[74] GHGs emissions include emissions from carbon dioxide (CO_2), methane, nitrous oxide, hydro-fluorocarbons, perfluorocarbons, nitrogen triflouride and sulphur hexafluoride in CO_2 equivalents.

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The energy and emission intensities of production in these sectors can be used to indicate the potential vulnerability of each sector to policy- or regulatory-induced changes in the price of emissions.[75] Although manufacturing accounts for between 12 and 18 per cent of sectoral emissions, its energy and emissions intensities are close to the mean for all sectors. In contrast, the water supply, sewerage and waste management sector accounts for a relatively small share of emissions but has an energy and emissions intensities well above the average. Output in agriculture has the highest GHG emission intensity due to its emissions of methane, while its carbon dioxide emissions intensity is low.[76] The transportation and energy generation sectors have the highest energy intensities. This suggests that these sectors, together with the emissions intensive agriculture and water and waste management sectors, could be the most affected by transition risks in the short to medium term

While fiscal authorities control the primary policy instruments that can mitigate climate-related risks, there is a growing recognition among central banks that these risks could affect their ability to meet price and financial stability objectives (Lagarde, 2021). Moreover, the broad-ranging impact of climate change, as well as the important role that central banks can play in financing the transition, places it firmly in the bailiwick of central banks (Makhlouf, 2021).

In this context, although there is broad acknowledgement that climate-related risks could have an increasingly adverse impact on the economy, relatively few studies examine the particular channels through which these risks affect the conduct of monetary policy, or the implications of these risks for central banks' analytical frameworks.[77] In this *Article*, we explore these issues. We first outline the main channels through which physical and transition risks affect output and inflation, and consider the key policy interventions that can mitigate these risks. We then examine how climate change presents analytical challenges for assessing the short-to medium-term trajectory of the economy and how this, together with its impact on the natural rate of interest, may complicate the calibration of the monetary stance. We also consider how climate change may alter the transmission of

[75] The energy intensity of production is calculated as the share of the sector's energy expenditure in its GVA. The GHG and CO_2 emissions intensities of production are calculated by dividing emissions in kilograms by gross value added in constant prices.
[76] See Conefrey et al (2022) for a discussion of the carbon intensity of employment across sectors in Ireland.
[77] Notable exceptions are Batten et al (2016) and Drudi et al (2021).

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monetary policy through conventional channels, which could change how central banks respond to aggregate economic shocks.

Finally, we discuss the conceptual and technical challenges of incorporating climate risks in the models typically used by central banks for policy and scenario analysis. These challenges stem from the long-term and persistent nature of the shocks arising from climate change, the global nature of the climate change externality, uncertainty about the stability of economic relationships, and the potential for non-linearities to amplify the impact of climate-related shocks. (Batten, 2018).

The focus of our analysis is on the macroeconomic impact of climate change. We therefore abstract from the important impact of climate change on the stability of the financial system. The interaction between climate and financial stability risks is examined in Donnery (2019), Lane (2019) and Madouros (2020), while the impact of climate change on bank supervision is discussed in Sibley (2021). This *article* accordingly tries to complement their analysis by providing a macroeconomic and monetary perspective on the broader implications of climate change for central banks.

The remainder of this article is structured as follows. Section 2 outlines the current policy and institutional context framing the transition to net zero. Section 3 presents an overview of the channels through which physical and transition risks can affect the economy, and examines the role of different transition policies. Section 4 discusses how these risks could affect the calibration and transmission of monetary policy, while Section 5 considers how they can be incorporated in the macroeconomic models typically used by central banks. Section 6 concludes.

2. Policy and Institutional Context

Carbon pricing policies represent a key component of the EU's strategy to combat climate change. Since 2005, the Emission Trading System (ETS) has regulated the emissions of entities involved in power and heat generation, energy intensive industrial activities, and aviation, which combined comprise 41 per cent of the EU's total emissions.[78] This 'cap-and-trade' system sets regulatory limits, or 'caps', on the total amount of certain GHGs that can be emitted in a

[78] The European Commission is currently considering proposals to include road transport, shipping and buildings in EU ETS.

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given year by these entities. Emissions permits are then issued that are consistent with that cap and these can be traded or auctioned between firms. The cap is reduced over time so that emissions fall. Since the introduction of the ETS, total emissions of the in-scope sectors have fallen by almost 43 per cent.

In addition to the ETS, European Commission has adopted a series of legislative proposals, as part of the 'European Green Deal' outlining how it intends to achieve net zero emissions in the EU by 2050. Through the 'fit-for-55' proposals it has also established an intermediate target of a minimum 55 per cent reduction in GHG emissions *relative to 1990 levels* by 2030 (European Commission, 2021). One of the primary policy vehicles achieving these targets and for financing the transition is the €750 billion Next Generation EU (NextGenEU) fund. At least 37 per cent of the resources available through NextGenEU are ring-fenced for climate and biodiversity projects.[79]

While Ireland is subject to EU emissions regulations such as the ETS, it has also announced its own plan to combat climate change. *Climate Action Plan 2021* documents the Irish government's strategy for achieving a 51 per cent reduction in GHG emissions *relative to 2018* levels by 2030 and reaching net zero emissions by 2050 (DECC, 2021). Table 2 outlines the emission reduction requirements and key policies proposed for each sector under the plan.

Table 2: Climate Action Plan: Emissions Reductions Targets and Policies

Sector (reduction)	Policy/Targets
Energy (62-81%)	• Increase renewable electricity – wind and solar up to 80% • Support scheme for micro-generation (plus feed-in tariffs) • New connectors/interconnections to Northern Ireland, Great Britain, and the EU • Complete the phase-out of coal and peat-fired electricity generation
Transport (42-50%)	• Increase the number of EVs to circa 1 million by 2030 • Enable 500,000 daily sustainable travel journeys by 2030

[79] Ireland will receive approximately EUR 500 million for climate-related initiatives including the retrofitting of public buildings, electrification of commuter rail and rehabilitation of peatlands (DEPR, 2021a).

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	• Expansion of rail services, and cycling and walking infrastructure • Increase the use of biofuels in transport
Business (29-41%)	• Introduce new obligation to ensure energy for heat comes from renewable sources • Prioritise longer-life and lower-carbon cement blends in public contracts • 80% of cement energy needs will come from alternative fuels and waste recovery • 50-60% of the total fuel demand for heating will be met by carbon-neutral heating.
Buildings (44-56%)	• Blend low-cost loans with SEAI grants to make retrofits affordable • Retrofit 500,000 homes to B2 BER / cost optimal equivalent or carbon equivalent • Install 400,000 heat pumps in existing homes and 250,000-280,000 in new homes • Roll out district heating scheme

Source: Climate Action Plan 2021

With the proposed introduction of carbon budgets, emissions in each sector would be required to fall by prescribed amounts by 2030, including by up to 81 per cent in the energy sector. The plan also includes a wide-ranging set of mitigation policies and regulatory changes. These include measures to boost energy efficiency through a large-scale retrofitting of the housing stock and commitments to raise the proportion of renewable electricity to 80 per cent by the end of the decade. An important driver of the decarbonisation process will be the legislated increase in the carbon tax, which will rise from its current level of €41 per tonne to €100 per tonne by 2030. The climate action plan is complemented by the €165 billion *National Development Plan 2021-2030*, which, through the electrification of transport and construction of low-carbon infrastructure, could facilitate a shift in the long-term energy mix of production and consumption towards sustainable alternatives (Krogstrup and Oman, 2019; DEPR, 2021b).

From a policy perspective, the intersection of climate change with areas of competency other than those of governments' is now widely recognised. In this context, the European Central Bank and the European System of Central Banks recently completed a monetary policy strategy review, which included an exploration of the channels through which climate change interacts with their collective primary and secondary mandates of, respectively, maintaining price stability

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and supporting the policies of the European Union.[80] It also published an action plan outlining its goals in terms of assessing the vulnerability of financial institutions to climate-related risks, augmenting its modelling frameworks to incorporate the impact of these risks on the economy, and adjusting its collateral operations and asset purchase programmes to include climate change criteria (ECB, 2021).

The challenge presented by climate change for central banks' ability to achieve their mandate is highlighted in the Central Bank of Ireland's new *Strategy* for the 2022-2026 period (CBI, 2021). In particular, the strategy emphasises the importance of being 'future-focused' in terms of anticipating how climate-related risks could inhibit its ability to meet its mandate, and adopting a 'safe-guarding' approach to monitoring and mitigating the potential impact of these risks risks on price and financial stability. The latter includes the development of analytical frameworks that capture appropriately the implications of both physical risks and primary policy mitigants on the economy. To operationalise this strategy, the Central Bank has implemented or participated in a number of initiatives including the establishment of a Climate Change Unit as a central hub for coordinating the Bank's work on climate change and becoming a member of the Network for Greening the Financial System (NGFS).[81]

3. Climate-Related Risks and the Transition to Net Zero

Physical and transition risks can be the source of significant shocks to the economy. In this section, we outline the channels through which these risks are transmitted and discuss how the shocks generated by the risks differ in their timing and persistence. We then examine the mix of climate-related policies that can minimise the economic cost of the transition to net zero emissions.

[80] See Corbisiero and Lawton (2021) for a discussion of the key findings from the *Strategy Review*.
[81] The NGFS is a consortium of central banks and supervisors that was formed in 2017 to "help strengthen the global response required to meet the goals of the Paris Agreement and to enhance the role of the financial system to manage risks and to mobilise capital for green and low-carbon investments" (NGFS, 2019a).

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3.1 Transmission Channels of Climate-Related Risks

Table 3 summarises how the shocks associated with each type of climate risk affect both the demand and supply sides of the economy.

Extreme events reduce output by damaging the productive capacity of the economy and causing disruption to the supply of intermediate goods.[82] These phenomena can lower consumption and investment by damaging household and firm assets, respectively. For example, if insurers consider these risks uninsurable, the losses arising from these events will have a larger impact on the balance sheets of firms and households, and likely reduce their ability to borrow due to lower collateral values (Donnery, 2019). Inflation levels (and volatility) may rise due to goods shortages.

Gradual warming is likely to have a negative impact on output, with higher temperatures reducing labour supply, labour productivity and investment being diverted towards adaptation technologies (such as air conditioning or insulation) and away from potentially more productive areas that could stimulate innovation (Fankhauser and Tol, 2005; Dell et al, 2014). For example, current evidence suggests that labour productivity falls by 2 per cent per degree above humans comfort temperature of between 18°C and 22°C (Heal and Park, 2016). The shift in consumer preferences towards low-carbon products and the change in comparative cost advantages across countries is likely to result in changes in relative prices. Rising sea levels, along with other geophysical changes, could also alter trade patterns by disrupting existing trade routes.

Transition risks arising from uncertainty about the trajectory of future policies reduce consumption and investment. In addition, cross-country differences in the stringency of climate policies can cause shifts in comparative cost advantage and thereby affect trade in intermediate and final goods. The supply potential of an economy might also be adversely affected by asset stranding and worker displacement in carbon-intensive sectors.

[82] While productivity may increase if firms in the reconstruction phase invest in newer technologies, the empirical evidence on the recovery of economies from extreme events suggests productivity growth does not recover to its previous trend in the aftermath of the event (Von Peter et al, 2012; Hsiang and Jina, 2014).

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Table 3: Macroeconomic risks from climate change

Shock	Variable	Extreme Events	Gradual warming	Transition Risks
Demand Shocks	Investment	Reconstruction. Investment delays from uncertainty about climate risks.	Change in preferences towards greener products	Crowding out' from climate policies. Uncertainty about transition path.
	Consumption	Uninsured damage to property could cause permanent decrease in wealth.	Change in preferences towards greener products	Crowding out' from climate policies. Shift towards greener consumption.
	Trade	Change in food prices. Disruption to trade flows.	Trade routes disrupted due to geophysical changes.	Distortions from asymmetric climate policies.
Supply Shocks	Labour Supply	Loss of hours worked due to natural disasters	Loss of hours worked due to extreme heat. International migration	Unemployment due to sectoral composition changes.
	Energy, food and other inputs	Food and other input shortages. Disruption to transport and production chains.	Decline in agriculture productivity and yields.	Risks to energy supply.
	Capital stock	Damage due to extreme weather.	Diversion of resources from productive investment to adaptation	Resources diverted to mitigation activities. Stranded assets.
	Technology, Productivity	Destruction of capital and infrastructure. Diversion of resources from productive investment to adaptation capital	Diversion of resources from innovation to adaptation capital. Lower labour productivity due to heatwaves.	Uncertainty about the rate of innovation and adoption of clean energy technologies.
Aggregate impact on Output and Inflation	Output	Physical destruction of capital. Supply chain disruption. Crop failures.	Investment diverted to mitigation. Lower labour productivity.	Frictions from distortive transition policies. Policy uncertainty.
	Inflation	Increased inflation volatility, particularly for food, housing and energy.	Relative prices changes due to shifting consumer preferences and changes in comparative cost advantages.	Prices affected by transition policies, policy uncertainty, technological changes and shifts in consumer preferences.
Timing of Impact		Short to medium run	Medium to long run	Short to medium run

Source: Adapted from Batten (2018) and Drudi et al (2021)

A key variable that determines the stance of monetary policy is the natural rate of interest, denoted r*. The natural rate of interest represents the real interest rate that is consistent with output equalling potential and stable inflation (Woodford, 2003; Laubach and Williams, 2003). When r* is low,

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central banks have less room to provide monetary accommodation through conventional monetary policy and thus face a higher probability of hitting the effective lower bound on interest rates (Mertens and Williams, 2019). The economic disturbances precipitated by climate-risks could put persistent downward pressure on r*. First, the reduction in the effective supply of labour from emigration, and higher morbidity and mortality, raises the amount of capital per worker and reduces its marginal product over the long term.[83] This would lower r*. Second, the decline in productivity growth from shocks driven by physical and transition risks could increase savings and reduce the natural rate, as shown in the Ramsey growth model (Ramsey, 1928).Third, uncertainty about future climate-related risks can lead to higher risk premia, which can lower r* by increasing the propensity to save,and the demand for safe assets, while reducing willingness to invest in risky assets (Caballero and Fahri, 2018; Bansal et al, 2019).

As discussed below, however, the downward pressure on r* from the impact of climate change could be mitigated by higher government spending. In addition, while the diversion of resources from innovation towards adaptation may lower productivity growth and thus r*, this could be outweighed by higher productivity growth arising from investment in green technologies. In this case, the a priori impact on r* is ambiguous.

Table 3 also shows how the timing of the impact of economic shocks varies according to each type of risk. As discussed in the next section, the differential timing and persistence of economic shocks driven by climate-related risks presents particular analytical challenges for central banks. Extreme weather events happen unexpectedly and therefore affect the economy in the short to medium run through the channels outlined above. In contrast, the economic impacts from global warming tend to manifest more slowly, with the full severity of its impact on the productive capacity of the economy arising over the medium to long run.

For transition risks, the sequencing of policy actions and pace of technological progress will heavily influence their impact on the economy. Figure 2 depicts the case of an 'orderly' or gradual transition, in which the gradual rise in the price of carbon, allows firms sufficient time to reduce the carbon-intensity of their production processes, while technological progress increases the availability of low-carbon substitutes and mitigates

[83] The impact on r* from migration is clearly heterogeneous across countries, as capital per worker would fall in those countries that receive migrants.

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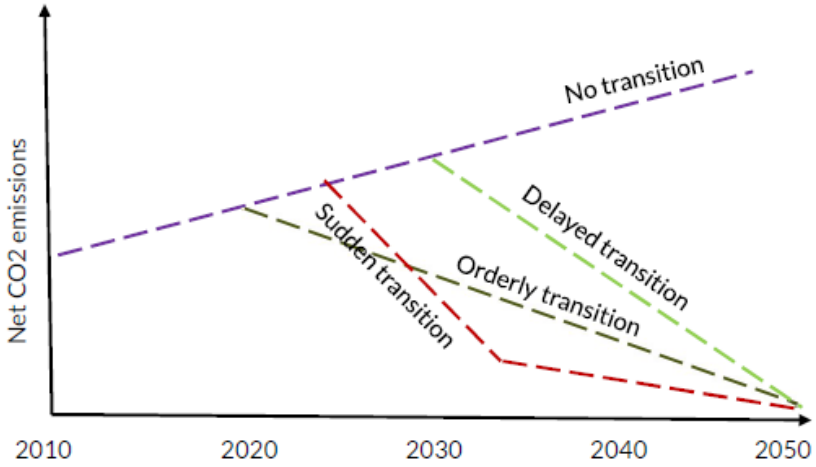
any sharp rise in energy prices. However, we can also consider scenarios in which the transition to a carbon-neutral economy is 'disorderly'. Figure 2 also shows two variants of the latter: a 'sudden' transition scenario in which the rapid shift away from carbon-intensive production leads to a spike in energy prices and a reduction in the supply of energy, and a 'delayed' transition scenario in which climate action is postponed until 2035 before highly stringent mitigation policies are introduced resulting in a sharp adverse productivity shock.

In these disorderly scenarios, investors may shift their portfolios away from 'brown' sectors resulting in the assets of firms in those sectors becoming 'stranded' or suddenly depreciating in value. Higher relative prices for carbon-intensive products may also lead to customers substituting away from these goods towards 'greener' alternatives.[84] These sudden adjustments could lead to a significant fall in aggregate output in the short to medium term.

Figure 2: Orderly and Disorderly Transition Paths to Net Zero



Source: Allen et al (2020)

3.2 Primary Policy Actions for the Transition to Net Zero

Transition risks associated with the path to a carbon-neutral economy can be mitigated through the expeditious implementation of a range of policies aimed at initiating changes in behaviour and facilitating green innovation.

[84] As discussed below, asset stranding can also lead to a rise in corporate insolvencies and increased risks to financial stability.

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Carbon pricing is widely seen as one of the key policy responses to achieving an 'orderly' transition.[85] By internalising the climate change effects associated with carbon emissions, carbon pricing incentivises household and firms to switch from high- to low-carbon activities (de Mooij et al, 2012; Drudi et al, 2021).[86] Moreover, predictable and gradual increases in carbon prices provide a signal to investors to shift resources from 'brown' to 'green' sectors and can therefore can spur investment in low-carbon technologies and infrastructure (Aghion et al, 2009). The sectoral shifts in production that are integral to the transition to a low-carbon economy can lead to worker dislocation in the short term. Higher carbon prices can also reduce real household incomes and can have a proportionately larger impact on low-income households (De Bruin et al, 2019b). Accordingly, recycling carbon tax revenues in the form of transfers to the most affected households and supports for labour market adaptation can help reduce the economic cost of the transition for those that are proportionately most affected (Black et al, 2021). Carbon revenues could alternatively be used to lower more distortionary taxes such as those on wages and profits, potentially yielding a 'double dividend' of reducing emissions while boosting growth (Bovenberg, 1999).

As policy instruments aimed at reducing GHG emissions, carbon taxes and cap-and-trade schemes with full coverage are broadly equivalent as both can achieve the same carbon price. While carbon taxes generate a more stable trajectory for carbon prices, the associated reduction in emissions is less predictable due to uncertainty about the future technologies and abatement costs (Drudi et al, 2021). In contrast, as cap-and-trade schemes impose regulatory ceilings on emissions that fall over time, they tend to lead to more stable emissions paths but more volatile carbon prices (Aldy and Stavins, 2012).

One concern that frequently follows the introduction of carbon pricing policies is that, in the absence of international coordination, higher domestic carbon prices could adversely affect a country's

[85] Carbon pricing policies also include the removal or phasing-out of fossil fuel subsidies. See De Bruin et al (2019a) for an analysis of the impact on the Irish economy of policies that simultaneously lower fossil fuel subsidies and raise carbon taxes.
[86]

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competitiveness.[87] This is a corollary of the 'pollution haven' hypothesis, which posits that carbon-intensive production could shift to countries with less stringent climate policies, resulting in 'carbon leakage'. This relocation of production if on a large scale could create pollution havens in the host economies (Levinson and Taylor, 2008). Empirical estimates of the pollution haven effect for EU countries suggest that emissions rise by up to 30 per cent in the rest of the world for each unit of EU emissions avoided, with leakage rates highest for emissions-intensive and trade-exposed industries such as cement, aluminium, steel and iron (Chen et al, 2020).

Carbon leakage can be mitigated via the implementation of a carbon border adjustment mechanism (CBAM), whereby countries impose tariffs on imports from countries with less stringent environmental policies (Parry et al, 2021). However, challenges to implementing a CBAM include the difficulty in measuring the emissions embodied in imports due to data constraints, the administrative burden, and the potential for retaliation.[88]

Effective carbon pricing regimes typically have several core features (IMF, 2019). First, the carbon price covers a broad range of emissions, as well as other environmental costs including traffic congestion and local air pollution.[89] Carbon prices should also reflect co-benefits or additional economic benefits that stem from climate policies, including their impact on innovation, resource allocation and productivity growth (Batten et al, 2020). Second, the trajectory of carbon prices over time should be gradual and predictable to spur investment in low-carbon technology. Third, the revenue generated from carbon pricing policies should be used efficiently, while some redistribution may also be needed to protect the real living standards of low-income households (Drudi et al, 2021).

[87] An alternative view, as encapsulated in the 'Porter hypothesis' (Porter, 1991; Porter and van der Linde, 1995), is that environmental regulations could lead to gains in international competitiveness by providing incentives for 'green' innovation that would not have happened in the absence of these regulations. However, there is little empirical evidence to support this view (Dechezlepretre and Sato, 2014).
[88] An alternative approach to reduce leakage would be for large economies to establish a "Green Club", which would set an international floor on carbon prices (Chen et al, 2020).
[89] An important feature of co-benefits is that they can be realised in the medium run, while the impact of mitigation policies on climate change likely only materialises in the long run (Batten et al, 2020).

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However, carbon pricing policies are only one of the necessary components of a successful transition to a low-carbon economy. Governments also have a key role in supporting the transition through complementary structural policies that facilitate the shift away from carbon-intensive activities. Investment in public transportation and urban infrastructure is particularly important as this type of public expenditure can lock in the long-term energy mix for the economy and embed behavioural changes initiated by higher carbon prices (Krogstrup and Oman, 2019).

Governments can influence the speed and timing of the transition through policies aimed at expediting the diffusion of green technologies, worker retraining, and supporting research and innovation. Governments may also have a role in the development of clean technologies, as the knowledge produced in development process is only partially excludible so its social benefits are not fully captured (Batten, 2018).[90] Similarly, the uncertain returns, large sunk costs, network effects and long time-horizons associated in particular with the development of these technologies rationalise government intervention (Acemoglu et al, 2016; Mazzucato and Penna, 2016; Hotte, 2020). Government support can then be withdrawn once the technologies are sufficiently mature (Acemoglu et al, 2012).

As discussed above, the economic shocks generated by climate-related risks could put downward pressure on the natural rate of interest, r*. However, fiscal policy related to the transition could offset some of these forces. By increasing investment in innovation and ensuring an orderly transition, governments can mitigate the uncertainty-driven rise in risk premia and boost future productivity growth. In addition, recycling carbon tax revenues to increase transfers to low-income households and reduce other distortionary taxes could spur consumption and investment. Both of these measures would mitigate the potential decline in r* from physical and transition risks.

[90] Dechezlepretre et al (2017) find that knowledge spillovers, as measured by patent citations, are significantly higher for 'green' compared to 'brown' technologies. They suggest that the knowledge spillover effect of low-carbon technologies is comparable to that from information and communications technologies (ICT).

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Finally, there are some concerns that the increase in transition-related government investment, together with the reconstruction and adaptation costs from global warming and more extreme weather events, will have significant implications for the stability of public finances, particularly in fiscally weaker countries (Darvas and Wolff, 2021; Zenios, 2021). In terms of the likely scale of expenditure, the European Green Deal assumes that additional (public and private) investment of close to two per cent of GDP per annum over the next decade will be needed to meet the EU's 2030 climate and energy targets. The extent to which the required increase in government spending will be financed by debt is uncertain (Pisani-Ferry, 2021). A key issue is how revenues from carbon taxes are recycled. If these revenues are ring-fenced to finance higher investment, support innovation, and reduce distortionary taxes, growth effects could help mitigate risks to fiscal sustainability (NGFS, 2021).

4. Climate Change and Monetary Policy

Central banks adopt a forward-looking approach to assess the key risks to meeting their primary objective of price stability over the medium term. Consequently, the calibration of the monetary stance requires identifying the nature, persistence and magnitude of shocks affecting the economy. As economic shocks can originate from climate-related risks over the time horizon that the stance is assessed, these risks could increasingly be of concern to monetary policymakers. We now examine how climate change could affect the conduct of monetary policy and the ability of central banks to achieve their primary mandates.

4.1 Analytical Challenges

As outlined in Table 3, climate change can affect the nature, timing and persistence of economic shocks hitting the economy. While climate-related shocks can affect both the demand and supply sides of the economy, disentangling one from the other is particularly challenging from an analytical perspective. Moreover, little is known about how these shocks interact and whether there are amplification mechanisms in these interactions that generate non-linear impacts on the economy.

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From a monetary policy perspective, climate-related risks can have differing implications for how a central bank should respond depending on how they affect the economy. For example, physical risks such as extreme weather events that affect the supply side of the economy will tend to lower output and raise inflation. Accordingly, and in contrast to demand side shocks, central banks face a trade-off between stabilising inflation and boosting economic activity. The typical monetary response in this case is calibrated based on the magnitude and persistence of the shock (Drudi et al, 2021). Central banks will tend to 'look through' shocks that are expected to be transitory but intervene in response to those that are likely to be persistent and feed back into inflation expectations. Climate change, by increasing the frequency, severity, and persistence of supply shocks, could therefore require a recalibration of central banks' monetary reaction functions to incorporate the potential impact of these shocks on price stability over the medium term (Boneva et al, 2021).[91]

In addition to physical risks, transition risks can also have implications for price stability. For example, higher carbon prices arising from carbon taxes or cap-and-trade schemes will tend to raise inflation in the short-term as low-carbon substitutes may not be readily available.[92] The dynamic effect of carbon policies on inflation will ultimately be determined by the transition path. For example, in an orderly transition, carbon prices rise steadily and predictably over time, thereby raising the price of carbon-intensive goods. Investment in green technologies increases the availability of low-carbon alternatives, which allows consumers to substitute away from increasingly expensive carbon-intensive goods. Therefore, the net impact of higher carbon prices on inflation should dissipate over time as the share of these goods in consumption falls. However, a persistent rise in inflation over the medium term due to carbon pricing policies may lead to tighter monetary policy in order to limit feedback to inflation expectations (Schnabel, 2022).

[91] The monetary policy rate typically influences economic activity over the short to medium term. However, if climate change shocks have a duration longer that the typical horizon of monetary policy, central banks may be unable to fully reverse their impact on the economy (Coeure, 2018; Villeroy de Galhau, 2019).
[92] See Kanzig (2021) for evidence on the impact of carbon price shocks on inflation.

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In the case of the euro area, differences in exposure to physical and transition risks suggests that climate change is likely to have heterogeneous effects across member countries. The diverse climate systems across the euro area imply differential regional vulnerability to physical risks. For example, the main physical risk affecting countries in the Northern Europe is higher precipitation which could lead to more frequent episodes of flooding. In contrast, countries in Central and Southern Europe are most vulnerable to higher temperatures and drought (European Environment Agency, 2017). While euro area countries are members of the EU's emissions trading scheme (EU ETS) which covers approximately 40 per cent of the EU's GHG emissions, differences in other transition policies and initial levels of emissions, could lead to considerable cross-cross heterogeneity in the impact of transition risks.

4.2 Potential Impact on Monetary Transmission Channels

Table 4 from Drudi et al (2021) outlines how each type of climate-related risk could interact with the main transmission channels of monetary policy.[93] As the relationship between climate change and monetary policy is a nascent area of research, the discussion here focuses on the conceptual issues and abstracts from the potential strength of the impacts on each channel. In the context of the euro area, it is also important to note that there is likely to be considerable cross-country heterogeneity in the impact of climate-related risks on these channels due to differences in countries' exposures to each type of risk.

The *interest rate channel* captures how a change in policy rates directly affects money-market rates and, indirectly, banks' lending and deposit rates. The change in short-term rates will also tend to raise long-term rates through the expectations hypothesis. As discussed above, the increase in risk aversion and uncertainty that stems from both physical and transition risks can lead to higher precautionary savings by households and lower investment by firms. A given change in interest rates will consequently have a smaller impact on the real economy, all else equal. The potential fall in the interest rate sensitivity of aggregate demand would therefore imply

[93] See Beyer et al (2017) for an overview of the transmission channels of monetary policy.

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a weakening of one of the key transmission channels of conventional monetary policy.

The *credit channel* reflects the importance of banks' balance sheets for the transmission of monetary policy. A policy-induced fall in interest rates increases borrowers' net worth by increasing the net present value of their assets, thereby raising the collateral values of such assets and increasing borrowers' ability to obtain credit. Climate-related risks can weaken the transmission of monetary policy through the credit channel via their impact on borrower creditworthiness and collateral values, which raises borrowing constraints for firms and households. In addition, if banks' balance sheets become impaired due to higher rates of borrower default, lending risk premia may rise. Both the decline in collateral values and rise in risk premia could then lead a contraction in the supply of loans to the real economy.

As discussed above, climate-related risks could lead to a lowering of equilibrium interest rates over the longer term. In addition to other factors that have been suppressing long-term rates, this could further lower net interest margins and bank profitability. As retained earnings are a key source of capital for banks (Cohen and Scatigna, 2016), this would weaken the ability of banks to expand their balance sheets and provide credit to the real economy.

Table 4: Impact of Climate Change on Monetary Policy Transmission

	Physical Risks From more common extreme weather events and persistent warming	**Transition Risks** From carbon pricing and reducing emissions
Interest rate channel	Non-interest cost factors become more relevant, lowering investment and saving response to interest rate changes.	Uncertainty about timing and speed of policy response raises risk premia and volatility. Natural rate of interest affected.
Credit channel	Financial losses reduce borrower net worth and bank collateral. NPLs constrain credit supply.	Financial losses reduce borrower net worth and bank collateral. NPLs constrain credit supply.
Asset price channel	Physical risks destroy capital and residential property. Financial losses lower firm valuations.	Demand shifts across sectors and regions. Stranded assets.
Exchange rate channel	Devaluation incentive for short-term competitiveness gain. Higher volatility.	Border carbon adjustment may disrupt trade routes and global value chains.

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Expectations channel	Monetary policy less predictable since shock persistence uncertain, blurring supply/demand.	Time-consistent transition policies reduce monetary policy credibility and effects.

Source: Drudi et al (2021)

The *asset price channel* captures how changes in policy rates affect the economy through changes in asset values. Climate-related risks could affect the transmission of monetary policy through this channel in several ways. More frequent extreme weather events could lead to greater volatility in financial markets due to their impact on the values of insurance companies, banks and non-financial firms. Physical risks can also reduce the value of residential and commercial property in exposed areas, which would lower the net worth of households and firms in those areas. Sudden changes in transition policies or in investor sentiment can lead to asset stranding and large write-downs in firms' capital values. These shocks to net worth are likely to adversely affect investment and consumption.

The *exchange rate* channel captures how an increase in domestic policy rates relative to policy rates in other countries can lead to a real appreciation of the domestic currency and reduce net exports. However, the increase in uncertainty and economic volatility due to climate change can weaken the transmission of monetary policy through the exchange rate channel. As climate-related risks can disrupt trade and alter the international pattern of production, the elasticity of demand with respect to a change in the exchange rate may fall over time.

Finally, the *expectations channel* captures the impact of monetary policy on expectations of future interest rates and inflation. Expectations of future interest rates are a key component of important economic decisions that have a long-term horizon such as fixed capital investment and durable consumption.[94] As climate change raises uncertainty about the future distribution of economic shocks, central banks' ability to guide private sector expectations about the future path of policy rates may also weaken and lead to higher inflation volatility.[95] In particular, the difficulty of

[94] See Blinder et al (2008) for a discussion of the role of expectations in the conduct of monetary policy.
[95] See Weitzman (2009) for a discussion of the potential distribution of climate risks.

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differentiating between shocks according to their nature and persistence could lead to policy errors, which would further complicate communication of the medium-term policy stance. Similarly, climate-related risks could further affect the expectations channel if, for example, carbon pricing policies are projected to generate persistently higher inflation or if the downward pressure on r* is likely to constrain future monetary policy.

5. Challenges for Macro-Modelling

This foregoing discussion has highlighted the potential impact of climate-related risks on the economy and the conduct of monetary policy. From an analytical perspective, this implies that central banks' forecasting and macro-modelling frameworks need to be modified to account for these risks. In terms of forecasting, there is evidence that including weather variables and changes in carbon prices significantly improves the performance of nowcasting and short-term forecasting models, particularly in relation to food and energy prices.[96] In this section, however, we focus on structural models that can be used by central banks for policy-relevant scenario analysis. We assess how traditional workhorse macroeconomic models can be augmented to capture the transmission to climate-related risks to the economy and financial system. [97] We also consider the role of integrated assessment models and outline how they could be combined with structural macroeconomic models to provide a comprehensive toolkit for assessing the impact of climate change.

5.1 Structural Macro Models

Structural macroeconomic models including Dynamic Stochastic General Equilibrium (DSGE) and macroeconometric models are typically the workhorse models used by central banks for policy and

[96] See Huurman et al (2012) and Guorio (2015) for evidence on how including weather conditions in forecasting models of output and inflation can significantly improve the accuracy of their forecasts.

[97] The discussion in this section focuses on how central banks' workhorse structural macroeconomic models can be augmented to incorporate climate-related risks and how climate-economy models such as IAMs could be used as satellite models in this existing macro-modelling framework. See NGFS (2019b) for a discussion of how other types of models such as, computable general equilibrium (CGE), agent based (ABMs), stock-flow consistent (SFC), network and overlapping generation (OLG) models, could also be used to assess the economic impact of climate change.

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scenario analysis.[98] As the integration of physical and transition risks in these models is still in its infancy, a common approach to modelling these risks has not yet emerged. We now explore how these models can be augmented to incorporate the relevant transmission channels to the domestic economy.[99]

Climate policy instruments such as carbon taxes affect the economy through their impact on relative energy prices and resemble a classic supply shock. To incorporate their impact on the supply side of the economy, the production function in the models needs to be modified. This can be achieved in several ways. The approach taken in Yoda (OECD, 2017) and GEM (CISL, 2015) is to allow carbon taxes, and thus energy prices, to affect total factor productivity (TFP).

An alternative approach is to include energy directly as a separate factor of production. In the NiGEM model, potential output takes the form of a production function in which a constant elasticity of substitution (CES) bundle of capital and labour is nested in a Cobb-Douglas function with energy and labour-augmenting productivity. The energy component is further decomposed into the output intensity of fossil fuels and renewables (NIESR, 2021). By modelling production in this way, disorderly transition scenarios can be generated in which the share of renewables rises abruptly due, for example, to an improvement in technology.[100] However, a key challenge that arises with this approach is the difficulty of specifying and calibrating a functional form for the substitutability between renewables and non-renewables due to data constraints. A further complicating factor is that this substitutability is likely to be influenced by technical innovation over time.

On the demand side of the model, carbon taxes affect consumer prices. As a change in the effective carbon tax rate is analogous to a

[98] See Clancy and Merola (2016), Conefrey et al (2018), Lozej et al (2018) and McInerney (2020) for details on the Central Bank's existing suite of structural macroeconomic models.
[99] While the discussion here focuses on semi-structural or macroeconometric models, the modelling challenges presented by climate-related risks are similar for DSGE models. In terms of the latter, see Golosov et al (2014) for an early DSGE model with environmental features and Drudi et al (2021) for a discussion of recent advances in environmental DSGE (E-DSGE) modelling.
[100] This shock to the share of renewable energy can be coupled with a write-down of the existing capital stock to represent the "stranding" of the capital assets of fossil-fuel intensive sectors. Vermeulen et al (2018) examine the impact of such a scenario on financial firms in the Netherlands.

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change in the indirect tax rate, pre-existing transmission channels in the model for the latter can be modified to incorporate the impact of carbon price policies. The implied change in the indirect rate can therefore also quantify the impact of a carbon tax change on government tax revenues. Different expenditure rules for carbon tax revenue can also be implemented to highlight the dependency of transition paths on the composition of fiscal policy (NGFS, 2021).

Section 3 outlined how physical risks could be transmitted internationally though trade channels, while international heterogeneity in climate policies could lead to shifts in the spatial pattern of production. Transition paths could vary across countries due to differences in existing capital stocks, productivity, socioeconomic conditions, and economic structure. In addition, transition risks that lead to higher risk premia and tighter credit conditions could be transmitted through international macro-financial linkages. Accordingly, structural models should be able to capture international spillovers from climate shocks, particularly for small open economies which are most exposed to these spillovers.[101] As discussed below, one approach would be to use a global model such as NiGEM as a satellite model to a more detailed country model. The latter is important in providing more detail on the domestic macro-financial impact of climate-related shocks and capturing potential heterogeneity in the transmission of these shocks across sectors.

Perhaps the most conceptually challenging aspect of using structural macroeconometric models to assess the impact of climate change is that unlike typical quantitative risks assessments, the probability distribution of risks derived from historical data may be uninformative about future climate change risks (Allen et al, 2020). As climate change may generate significant structural shifts in the economy, economic relationships that held in the past, and which are embedded in the models, may not continue to hold in the future (Drudi et al, 2021). In this context, scenario analysis could be used to address these limitations (Bolton et al, 2020). This allows central

[101] Incorporating international transmission channels is also important for analysing issues related to 'carbon leakage' and the introduction of a carbon border adjustment mechanism. For example, in NiGEM, countries that have implemented carbon taxes can form a "Green Club" that imposes a carbon adjustment tax on imports from non-members (NIESR, 2021).

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banks to incorporate model and parameter uncertainty through a range of assumptions about the long-term impact of physical risks, the timing and stringency of transition policies, the rate of technological progress, and potential shifts in consumer preferences.

5.2 Integrated Assessment Models

Integrated Assessment Models (IAMs) have been used extensively to inform policymakers and make important contributions to the economic assessment of climate change policies in several recent reports of the IPCC (IPCC, 2014, 2018). These models typically include climate, energy and economic modules, which makes them particularly useful for modelling physical and transition risks.

IAMs can be used to generate the most cost-effective path for the economy to meet an exogenous climate or emissions target and therefore do not need to specify a 'damage function' (Drudi et al, 2021).[102, 103] These models simulate the changes in energy demand, land use and policy that would be needed to meet a particular temperature or emissions trajectory (NGFS, 2021). One of the key variables in IAMs is the (shadow) price of emissions, which is defined as the marginal abatement cost of an additional tonne of GHG emissions (Batten, 2018). This price is an important indicator of transition risk and is determined by the stringency and coverage of policies ('policy intensity'), the availability of clean technologies, and consumer preferences for carbon-intensive goods.

Transition trajectories will also depend on assumptions made about the availability of carbon capture and storage (CCS) and carbon dioxide removal (CDR) processes. These processes allow for the removal or capture of carbon from the atmosphere through, for example, afforestation, soil sequestration and bioenergy crops (Batten, 2018). For similar reasons, the agriculture, forestry and land modules in IAMs provide important information on how adaptation in these sectors could lead to significant reductions in emissions intensity through carbon sequestration.

[102] The discussion here focuses on 'cost effectiveness' IAMs. These models differ from 'cost-benefit' IAMs in that they take the global warming target and corresponding trajectory for emissions as given rather than solving for these values endogenously.
[103] A damage function specifies the impact of higher temperatures on GDP and productivity and thus enables these models to capture the feedback loop between economic activity, emissions, and global warming.

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Incorporating physical risks in IAMs changes the optimal transition path by raising carbon prices in short to medium term and lowering the rate of increase in the longer term (NGFS, 2021). Physical risks will also affect the transition paths of other key variables including energy use and investment. The impact of chronic physical risks on the economy can be quantified through a damage function, although there is considerable uncertainty about how to appropriately specify and calibrate these functions (Pindyck, 2013, de Bruin and Krishnamurthy, 2021).[104]

5.3 A Suite-of-Models Approach

As IAMs and structural macroeconomic models have different strengths in terms of elucidating the channels through which climate change affects the economy, an optimal strategy for central banks from a modelling perspective might be to adopt a 'suite-of-models' approach that utilises the output of both types of models in a single analytical framework. In this type of modular framework, satellite IAMs and workhorse structural macroeconomic models could also be combined with Input-Output models to facilitate a sectoral analysis of the economic impact of climate change, and with loan-loss models to allow for the stress testing of banks' balance sheets under different climate risk scenarios.[105]

Following NGFS (2021), Figure 3 illustrates how climate-related risks could be incorporated in central banks' macro-modelling framework through a suite-of-models approach. This framework has three components. The IAM generates scenarios for the relevant climate and economy variables including mitigation costs, carbon prices, land use, energy system characteristics, and energy-related technological progress that are consistent with a given emission pathway. The implied physical risks arising from each scenario can also be simulated post-recursively using an IAM damage function.

[104] IAMs have several limitations including their parsimonious representations of economic relations, their inclusion of only a limited number of transmission channels, and the sensitivity of results to the inclusion of particular feedback mechanisms (Batten, 2018; Dietz et al, 2021). In addition, most IAMs do not incorporate potential tipping points, non-linearities and irreversible damage from global warming and may therefore underestimate the impact of climate-related risks (NGFS, 2021).

[105] See Vermeulen et al (2018) and Allen et al (2020) for examples of suite-of-models approaches to stress-testing banks' balance sheets for climate-related risks.

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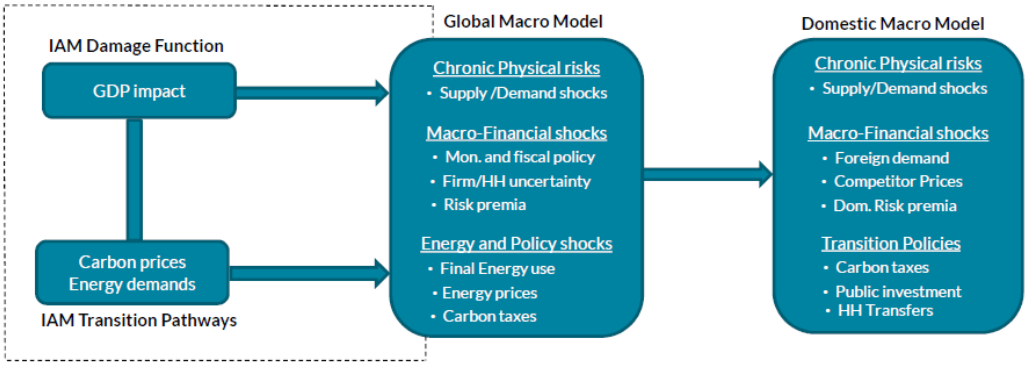
The second component of this framework is a global structural model. NGFS (2021) outlines how the outputs from the IAM can be mapped to a global structural model such as NiGEM in the form of shocks to supply and demand in the case of physical risks, and constraints on the trajectories of energy use, carbon prices and technological progress in the case of transition risks. As discussed above, structural macroeconomic models also need to be augmented to incorporate the transmission mechanisms through which climate-related risks affect the economy (Allen et al, 2020; Drudi et al, 2021). NIESR (2021) outlines how NiGEM has been modified to incorporate transmission channels for climate-related risks, including the impact of carbon taxes on production and consumption, changes in the energy intensity of production. Box A outlines in more detail how the NGFS has combined outputs from NiGEM and an IAM to simulate the impact of different transition scenarios on the global economy.

The final component of the framework is a structural macroeconomic model of the domestic economy. As discussed above, these models can be augmented to incorporate climate-related risks through modification of the supply, price-setting and fiscal blocks of the model. The primary advantage of integrating climate features into a model of the local economy, is the level of macro-financial detail it provides relative to a country block in a large global model, which typically is highly parsimonious and has similar specifications for each of the model's equation across countries. In contrast, a single country macroeconomic model can integrate country-specific features such as differences in the energy intensity of production or in risk premia across sectors.

Figure 3: Framework for Modelling Climate-related Risks



Source: adapted from NGFS (2021)

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In Figure 3, the paths of external variables such as imported fossil fuel prices, competitor prices, and foreign demand that are generated by NiGEM can be imposed on the domestic model. These variables capture the spillover of international climate risk shocks to the domestic economy. Similar to the approach in NiGEM, physical risks can be incorporated through supply and demand shocks that are calibrated from the IAM. Finally, domestic transition risks can also be simulated through shocks to investment premia, carbon taxes and fiscal policy instruments.

Box A: The Economic Impact of Different Transition Scenarios

In this Box, we illustrate the economic impact of different transition scenarios designed by the NGFS. We focus on the international impact of each scenario to highlight the potentially large spillovers to Ireland that may arise from transition policies in other countries. These simulations can also provide insights into the key channels through which climate-related risks can affect the Irish economy and can accordingly be used to inform the ongoing process of incorporating these risks in the Central Bank's macroeconomic models. Moreover, they highlight the importance of modifying these models so that the relative importance of different transition risks can be assessed. This would then aid policymakers on how fiscal and macroprudential policies could be recalibrated to mitigate the impact of these risks on the economy and financial system.

As mentioned above, NGFS (2021) outlines how the outputs of IAMs can be combined with those of a global model such as NiGEM model can be used to estimate the impact of these scenarios on the global economy. The IAMs determine the pathways of energy, land, climate and economic systems that are consistent with a given trajectory for carbon emissions. The outputs of these models are then used as constraints on the baseline paths of GDP, population and primary energy consumption in NiGEM. Each scenario in NiGEM subsequently incorporates transition and physical shocks consistent with the IAM pathways. The former mainly comprise of shocks to carbon taxes, energy intensity and risk premia, while the latter include shocks to domestic demand, labour productivity and trend capacity.

We focus on three scenarios: a scenario reflecting an 'orderly' transition, *Net Zero 2050*, and two scenarios reflecting a 'disorderly' transition, *Divergent Net Zero* and *Delayed transition*. Table A outlines the key assumptions underlying each scenario. The policy target indicates the degree of physical risk incorporated in the scenario, with those scenarios that achieve net zero emissions by 2050 and limit global warming to 1.5°C above pre-industrial levels having the lowest physical risks. The remaining columns of

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Table A indicate the degree of transition risk associated with each scenario across several dimensions. The timeliness, stringency and coverage of climate policies is a key determinant of the economic disruption generated by each transition pathways. The *Net Zero 2050* scenario will thus have significantly lower transition risks than the other scenarios as it assumes that the implementation of these policies is immediate and smooth. Similarly, while technological change in terms of the development of low-carbon technologies is also important to minimising the economic costs of transition, sudden or abrupt changes in the availability of these technologies can lead to significant disruption by rendering existing production processes obsolete and precipitating a sharp depreciation in the asset values of firms in carbon-intensive sectors.

Table A: Scenario Assumptions

Scenario	Policy Target	Policy Reaction	Technology Change	Carbon Removal	Regional Variation	Carbon Prices[106]
Net Zero 2050	1.5°C	Immediate and smooth	Fast change	Medium use	Medium variation	US$3 to US$673 (2020-2050)
Divergent Net Zero	1.5°C	Immediate but divergent	Fast change	Low use	High variation	US$3 to US$783 (2020-2050)
Delayed Transition	1.8°C	Delayed	Slow/Fast change	Low use	Medium variation	US$2.50 to US$623 (2030-2050)

Source: NGFS (2021)

Table A shows that technological change in the scenarios is mainly assumed to be fast, which accordingly contributes to higher transition risks in the short to medium term. The scenarios are also differentiated according to the assumed availability of carbon dioxide removal (CDR). CDR, through for example afforestation, lowers transition risks as it reduces the need for abrupt changes in other parts of the economy in order to achieve a given emissions target. Transition risks also increase according to the degree of policy heterogeneity across regions and sectors. A high degree of policy asymmetry, can lead to disruptive shifts in the composition of production, trade and consumption. The final column of Table A shows the increase in carbon prices in each scenario, which is a function of each of the transition risks in the table. Carbon prices rise steadily from 2020 onwards in the *Net Zero 2050* and *Divergent Net Zero* scenarios, although at a slightly higher rate in the latter. In contrast, carbon prices in *Delayed transition* scenario

[106] Carbon prices are reported in terms of 2010 US dollars/tonne CO_2.

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remain flat until 2030, after which they increase at a much steeper average rate than in the other scenarios.

To assess the economic effects of different transition paths, we simulate the three scenarios in NiGEM up to 2050. [107, 108] The baseline scenario against which we benchmark the results is assumed to be 'climate neutral' and thus does not incorporate the impact of physical or transition risks on the economy. It also assumes that population and productivity growth continue in line with past trends, while the pathway for GDP is adjusted to account for the short-term impact of COVID-19 on growth rates.

Figure A shows the impact of each scenario on GDP in the Euro Area, China, US, along with the global weighted-average. In the case of the *Net Zero 2050* scenario, the impact on Euro Area GDP is positive as the negative impact on demand from higher carbon prices and energy costs is more than offset by the use of carbon tax revenues to boost government investment and to reduce distortionary (mainly labour) taxes. In contrast, the impact on China and the US is negative in the medium to long term, reflecting the greater intensity of fossil fuels in production in those countries compared to the Euro Area.

The more severe impact on GDP in the *Delayed* relative to the *Net Zero 2050* scenario highlights the benefits of the early introduction of mitigation policies. The sharp rise in energy prices from the sudden implementation of stringent carbon pricing policies increase in carbon prices leads to higher production costs for firms and reduces households' real incomes. The delayed policy response generates uncertainty about the future trajectory of climate policies, which dampens private investment through higher risk premia. In addition, lower government spending and the reduced availability of CDR technologies increase the cost of transition relative to the orderly scenario. The delay in implementing mitigation policies also leads to an increase in physical risks, which have a negative impact on both the supply and demand sides of the economy. In this scenario, each economy experiences a sharp drop in output, with Euro Area output almost four per cent below baseline by 2050.

[107] The underlying scenario files were obtained from the National Institute for Economic and Social Research.
[108] NGFS (2021) uses three different IAMs to generate the transition pathways: GCAM, MESSAGEix-GLOBIOM and REMIND-MAgPIE. These models differ according to several features including whether they are partial or general equilibrium, their regional and sectoral granularity, and whether agents have perfect foresight or backward-looking expectations. The results we use in our scenarios are from REMIND-MAgPIE, which is a general equilibrium, perfect foresight model.

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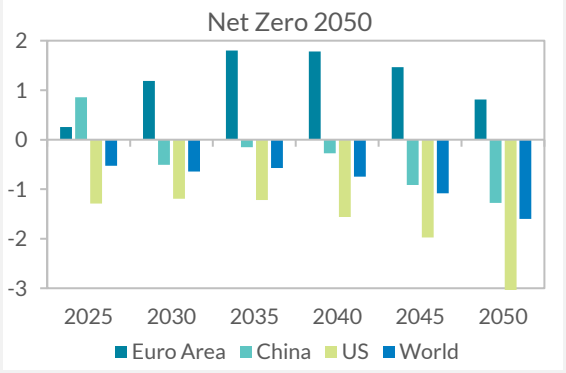
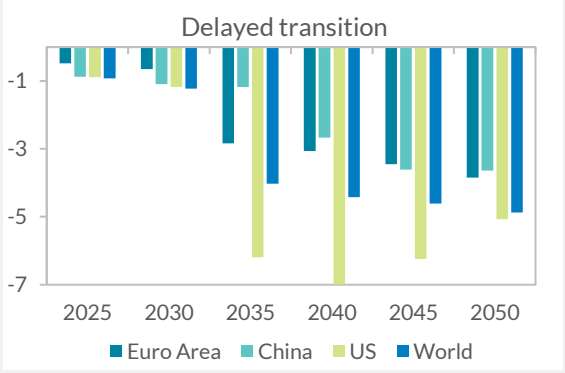
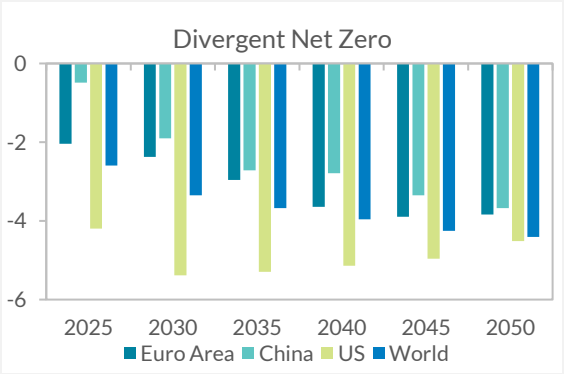
Figure A: Impact on GDP of Orderly vs Disorderly Transitions (% deviation from baseline)







Source: author's calculations, NIGEM.

The *Divergent* scenario shows a slightly smaller impact relative to the *Delayed* scenario but with adverse effects occurring much earlier. A key driver of the negative GDP impact in the *Divergent* scenario is the asymmetry in climate policies across sectors. In particular, carbon prices for the transport and building sectors are assumed to be three times those in the industry sector. As shown in Table A, aggregate carbon prices also rise more steeply than in the orderly scenario. As carbon tax revenues are assumed to be used to reduce government debt rather than raise government investment as in the orderly scenario, the negative impact of higher carbon taxes is not offset by government stimulus. Moreover, the sectoral divergence in climate policies generates higher uncertainty, which raises risk premia and lowers private investment.

Figure B illustrates the contribution of transition and physical risks to determining the overall impact on Euro Area GDP. The results for the *Net Zero 2050* scenario highlight the role of governments can play in supporting the transition. While the impact of carbon taxes is negative, this could be offset, depending on the size of multipliers, by recycling the revenues from the tax into higher investment and lower labour taxes. In the *Delayed* and *Divergent* scenarios, the key drivers of fall in output relative to baseline are higher carbon taxes and physical risks. However, the impact of these shocks is not mitigated by expansionary fiscal policy as it is in the *Net Zero 2050* scenario. Instead,

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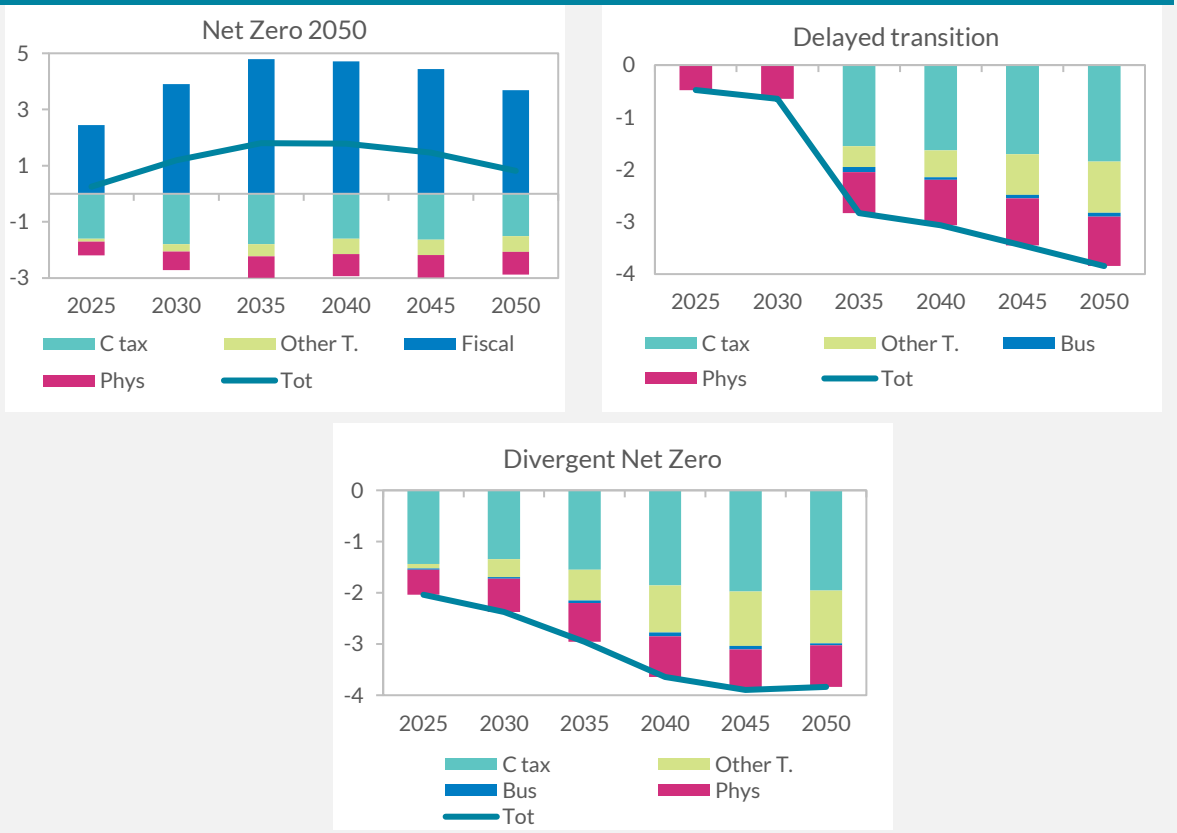
carbon tax revenues are used to reduce government debt. Although this reduces sovereign risk premia, it has a much lower stimulatory effect on the economy in the model than fiscal expansion through, for example, higher investment.

Figure B: Decomposition of Impact on Euro Area GDP (% deviation from baseline)



Source: author's calculations, NIGEM.
Notes: 'C tax' are carbon taxes, 'Other T.' are other transition risks excluding carbon taxes, 'Fiscal' are fiscal policies, 'Bus' are investment risk premia shocks, 'Phys' are physical risks, and 'Tot' is total impact.

It is important to emphasise that, while our analysis focuses on the economic (output) impact of different transition pathways as a proxy for welfare, there are other dimensions of the transition such as biodiversity losses, environmental damages, and distributional issues that influence welfare. Accordingly, our results thus have the narrow interpretation that transition pathways that are characterised by the delayed or uncoordinated implementation of climate policies, tend to have a more negative impact on the economy than those that are characterised by an orderly and expeditious implementation of policies.

6. Conclusion

In this *Article* we discuss the challenges that climate-related risks present for central banks from both an analytical and policy perspective. Physical and transition risks generate economic shocks that affect both the supply

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and demand sides of the economy. Differences in the timing and persistence of these shocks can complicate an assessment of the cyclical position of the economy, and thus the calibration of the monetary stance.

Climate-related risks could affect the transmission of monetary policy through a number of channels. For example, if banks' balance sheets become impaired due to losses arising from these risks, the transmission of monetary policy though the credit channel may weaken. Climate change could also affect the conduct of monetary policy through its impact on the natural rate of interest. In particular, uncertainty about the future distribution of climate-related risks could put downward pressure on the natural rate by increasing risk aversion and precautionary saving. This would reduce monetary policy space and increase the likelihood of hitting the effective lower bound.

Finally, we highlight the importance for integrating climate-related risks in central banks' short-term forecasting and macro-modelling frameworks. Forecasting models, particularly those for food and energy prices, can be augmented with weather and climate policy variables to improve their accuracy. Structural macroeconomic models can also be modified to incorporate the transmission channels for different types of climate-related risks. However, we also emphasise the benefits of a suite-of-models approach, in which the output of models with detailed climate-economy interactions such as IAMs could be combined with that of a structural macroeconomic model. As part of this approach, the Central Bank is currently augmenting its macro-modelling framework to include the key channels through which climate-related risks could affect the Irish economy and banking system.

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