Appendix A: Summary of key forecast assumptions by Iana Liadze, Jason Lennard and Graham Hacche

The forecasts for the world economy and the UK economy reported in this *Review* are produced using the National Institute's global econometric model, NiGEM. NiGEM has been in use at NIESR for forecasting and policy analysis since 1987, and is also used by a group of more than 40 model subscribers, mainly in the policy community. Most countries in the OECD are modelled separately,[1] and there are also separate models for China, India, Russia, Brazil, Hong Kong, Taiwan, Indonesia, Singapore, Vietnam, South Africa, Latvia, Lithuania, Romania and Bulgaria. The rest of the world is modelled through regional blocks so that the model is global in scope. All models contain the determinants of domestic demand, export and import volumes, prices, current accounts and net assets. Output is tied down in the long run by factor inputs and technical progress interacting through production functions, but is driven by demand in the short to medium term. Economies are linked through trade, competitiveness and financial markets and are fully simultaneous. Further details on NiGEM are available on http://nimodel.niesr. ac.uk/.

The key interest rate and exchange rate assumptions underlying our current forecast are shown in tables A1–A2. Our short-term interest rate assumptions are generally based on current financial market expectations, as implied by the rates of return on treasury bills and government bonds of different maturities. Long-term interest rate assumptions are consistent with forward estimates of short-term interest rates, allowing for a country-specific term premium. Where term premia do exist, we assume they gradually diminish over time, such that long-term interest rates in the long run are simply the forward convolution of short-term interest rates. Policy rates in many major advanced economies are expected to remain at low levels at least throughout this year.

The Reserve Bank of Australia and the central bank of New Zealand lowered their benchmark interest rates in 2016 and have kept them unchanged since. The central bank of Australia cut its rate by 50 basis points in two steps and the central bank of New Zealand reduced its rate by 75 basis points in three rounds. The People's Bank of China and the Indian central bank both reduced their interest rates throughout 2015 by a total of 125 basis points each. While the People's Bank of China has left theirs unchanged since, the Indian central bank lowered its benchmark rate further by 50 basis points in two rounds in 2016. After reducing its policy rate by 100 basis points in four steps between August 2014 and June 2015, the Bank of Korea cut it again by 25 basis points in June 2016. Indonesia's central bank reduced its benchmark interest rate by 25 basis points in February 2015, for the first time since 2012, and then lowered it again by 100 basis points in 2016 in four steps. However, after introducing a new policy rate in August 2016 – the 7-day reverse repurchase rate – the interest rates were lowered in two further steps, by 25 basis points in each case. Throughout 2014 and 2015, the Romanian Central Bank reduced its benchmark interest rate by a total of 225 basis points in nine steps and has kept it unchanged since. The National Bank of Hungary has brought its policy rate down by 120 basis points over eight rounds between the beginning of 2015 and May 2016 and retained it at 0.9 per cent since. The central banks of Norway and Poland have lowered their policy rates by 50 basis points each in 2015, to 0.75 and 1.5 per cent respectively. The central bank of Norway cut its benchmark rate further by 25 basis points in March 2016, while the central bank of Poland has left its rate unchanged. Over the course of 2015, the Swedish Riksbank cut its policy rate by 35 basis points in three rounds and lowered it again, by 15 basis points, at the beginning of 2016. At the time of writing, the Riksbank's policy rate stands at –0.5 per cent. At the turn of 2015 the Swiss National Bank cut its benchmark rate by 25 basis points to –0.75 per cent, while the Central Bank of Denmark reduced its rate by 15 basis points to just 0.05 per cent. Both central banks have left their main policy rate unchanged since. The Central Bank of Russia has continued to loosen the stance of monetary policy by reducing its base rate by 25 basis points to 9 per cent in June. After almost two years of holding the policy rate at 0.5 per cent, the Bank of Canada raised its benchmark rate by 25 basis points in July. Following the easing of

inflationary pressures, the Central Bank of Brazil cut its interest rate by 100 basis points in May – in total a 400 basis point reduction in the past two years.

In contrast, after a spell of reductions in interest rates by the Central Bank of Turkey in 2014 and 2015, inflationary pressures led to an increase in the benchmark rate by 50 basis points in November 2016. The South African Reserve Bank increased its benchmark rate by 50 basis points in two rounds in 2015 – the first time since 2008 – and then raised it further by 75 basis points in two rounds last year. Increases in the target range for the federal funds rate by the US Federal Reserve since December 2015 placed downward pressure on the Mexican peso. In order to stem this pressure, the central bank of Mexico increased its policy rate by 400 basis points in ten rounds between December 2015 and June 2017. These were the first increases since August 2008.

In mid-June 2017, the US Federal Reserve raised its target range for the federal funds rate by 25 basis points to 1–1.25 per cent – the fourth such increase since December 2015. Its median expectation of the future path of the rate remained largely unchanged from March, with one further such increase expected in 2017 and three more in each of the next two years. The Committee viewed the near-term risks to the outlook as roughly balanced, and said that it was "monitoring inflation developments closely" in relation to its "symmetric inflation goal".

For the UK, the expectation of the first rate change by the Monetary Policy Committee (MPC) of the Bank of England is based on our view of how the economy will evolve over the next few years. As discussed in the UK chapter in this *Review*, we expect the UK economy to experience a slowdown as a consequence of the vote to leave the EU.

At its August 2016 meeting, to mitigate the expected downturn, the MPC introduced monetary stimuli, which included a reduction in Bank Rate by 25 basis points to 0.25 per cent, the purchase of £60 billion of government bonds and a programme of £10 billion of purchases of sterling–denominated corporate bonds. At the time of writing, financial markets expect the MPC to raise rates to 50 basis points at the beginning of 2019, and to 70 basis points in the first half of 2020. Our view differs in that we prescribe removal of the recently introduced 25

Table A1. Interest rates *Per cent per annum*

		Central bank intervention rates					10–year government bond yields				
		US	Canada	Japan	Euro Area	UK	US	Canada	Japan	Euro Area	UK
2013		0.25	1.00	0.10	0.56	0.50	2.3	2.3	0.7	2.7	2.4
2014		0.25	1.00	0.10	0.16	0.50	2.5	2.2	0.6	1.9	2.5
2015		0.26	0.65	0.10	0.05	0.50	2.1	1.5	0.4	1.0	1.8
2016		0.51	0.50	−0.08	0.01	0.40	1.8	1.3	0.0	0.7	1.3
2017		1.11	0.67	−0.10	0.00	0.25	2.4	1.8	0.1	1.1	1.3
2018		1.89	1.20	−0.12	0.00	0.48	2.9	2.5	0.3	1.6	1.9
2019–2023		3.11	2.76	0.18	1.07	1.52	3.7	3.7	1.1	3.0	3.2
2015	Q1	0.25	0.81	0.10	0.05	0.50	2.0	1.4	0.3	0.8	1.6
2015	Q2	0.25	0.75	0.10	0.05	0.50	2.2	1.6	0.4	1.0	1.9
2015	Q3	0.25	0.54	0.10	0.05	0.50	2.2	1.5	0.4	1.2	1.9
2015	Q4	0.29	0.50	0.10	0.05	0.50	2.2	1.5	0.3	1.0	1.9
2016	Q1	0.50	0.50	0.00	0.04	0.50	1.9	1.2	0.1	0.8	1.5
2016	Q2	0.50	0.50	−0.10	0.00	0.50	1.7	1.3	−0.1	0.7	1.4
2016	Q3	0.50	0.50	−0.10	0.00	0.34	1.6	1.1	−0.1	0.4	0.8
2016	Q4	0.55	0.50	−0.10	0.00	0.25	2.1	1.5	0.0	0.8	1.3
2017	Q1	0.80	0.50	−0.10	0.00	0.25	2.4	1.7	0.1	1.1	1.3
2017	Q2	1.05	0.50	−0.10	0.00	0.25	2.3	1.5	0.0	1.0	1.0
2017	Q3	1.25	0.69	−0.10	0.00	0.25	2.3	1.9	0.1	1.1	1.4
2017	Q4	1.33	1.00	−0.11	0.00	0.25	2.5	2.1	0.2	1.3	1.5
2018	Q1	1.50	1.00	−0.11	0.00	0.42	2.7	2.3	0.2	1.4	1.7
2018	Q2	1.80	1.14	−0.12	0.00	0.50	2.8	2.4	0.3	1.5	1.8
2018	Q3	2.01	1.27	−0.12	0.00	0.50	2.9	2.6	0.4	1.7	2.0
2018	Q4	2.25	1.41	−0.13	0.00	0.50	3.1	2.7	0.4	1.8	2.1

Table A2. Nominal exchange rates

		Percentage change in effective rate							Bilateral rate per US $			
	US	Canada	Japan	Euro Area	Germany	France	Italy	UK	Canadian $	Yen	Euro	Sterling
2013	2.9	−3.1	−16.7	5.5	2.8	3.0	3.6	−1.2	1.039	97.6	0.753	0.640
2014	4.1	−5.5	−5.1	3.4	1.6	1.7	3.0	7.7	1.112	105.8	0.754	0.607
2015	13.7	−10.7	−5.7	−5.0	−3.1	−3.2	−2.1	6.5	1.299	121.1	0.902	0.654
2016	5.6	0.9	16.0	5.5	2.5	2.8	3.5	−9.6	1.314	108.8	0.904	0.741
2017	1.4	1.2	−2.3	1.9	0.7	1.6	1.5	−5.3	1.308	112.8	0.901	0.783
2018	−1.6	2.5	−0.4	2.1	1.1	1.1	1.3	0.1	1.269	112.5	0.872	0.768
2015 Q1	6.2	−6.9	−0.5	−3.7	−2.3	−2.4	−1.7	2.9	1.262	119.1	0.888	0.660
2015 Q2	0.8	2.4	−1.3	−1.2	−0.8	−0.5	−0.5	2.6	1.237	121.4	0.905	0.652
2015 Q3	3.4	−6.1	1.7	2.3	1.3	1.2	1.4	2.0	1.327	122.2	0.899	0.646
2015 Q4	2.2	−2.5	2.3	1.1	0.6	0.3	0.9	−0.3	1.370	121.5	0.914	0.659
2016 Q1	1.6	4.5	6.9	2.8	1.4	1.3	1.8	−5.5	1.323	115.2	0.908	0.699
2016 Q2	−1.5	2.2	5.7	1.0	0.4	0.8	0.6	−1.7	1.289	107.9	0.886	0.697
2016 Q3	1.2	−1.1	5.8	0.2	−0.1	0.4	−0.1	−7.9	1.310	102.4	0.896	0.762
2016 Q4	3.5	−0.6	−3.9	0.0	−0.1	0.2	0.3	−2.6	1.333	109.5	0.927	0.805
2017 Q1	1.1	−0.1	−2.9	−0.7	−0.4	−0.2	−0.3	0.7	1.339	113.6	0.939	0.807
2017 Q2	−2.2	−1.1	1.0	1.4	0.7	0.8	0.8	1.2	1.344	111.1	0.908	0.781
2017 Q3	−1.8	5.1	−2.5	2.5	1.3	1.3	1.6	−0.7	1.275	113.3	0.877	0.771
2017 Q4	−0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.272	113.3	0.877	0.771
2018 Q1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.272	113.3	0.877	0.771
2018 Q2	−0.1	0.1	0.4	0.3	0.2	0.2	0.2	0.1	1.271	112.8	0.874	0.769
2018 Q3	−0.1	0.1	0.4	0.4	0.2	0.2	0.2	0.1	1.269	112.3	0.870	0.766
2018 Q4	−0.1	0.1	0.4	0.4	0.2	0.2	0.3	0.1	1.266	111.7	0.866	0.764

basis point cut at the beginning of next year and then following the UK's two–year negotiated withdrawal from the EU we expect a further 25 basis point rise in May 2019. Bank Rate is expected to reach 2 per cent in the second half of 2022, this being the point at which the MPC is assumed to stop reinvesting the proceeds from maturing gilts it currently holds, allowing the Bank of England's balance sheet to shrink 'naturally'.

The European Central Bank (ECB), at its June 2017 meeting, left its interest rates and asset purchase programme unchanged but removed the downward bias from its forward guidance on interest rates. The Bank of Japan has left its policy parameters unchanged in recent months.

The central banks of the Euro Area (ECB) and Japan (BoJ) continue to expand their balance sheets. The 'expanded asset purchase programme' by the ECB, which began in March 2015, envisaged combined purchases of assets amounting to €60 billion a month until at least September 2016. In April 2016, monthly purchases increased to €80 billion and were expected to "run until end-March 2017, or beyond, if necessary". With inflation remaining well below the ECB's objective

of "below, but close to, 2 per cent", in December 2016, the ECB announced that its asset purchase programme would be extended to at least December 2017, but that starting in April purchases would revert to amounts of €60 billion per month. Recently the ECB confirmed that its net asset purchases of EUR 60 billion a month "are intended to run until the end of December 2017, or beyond if necessary, and in any case until the Governing Council sees a sustained adjustment in the path of inflation consistent with its inflation aim".

In October 2014, the BoJ announced that it would expand its asset purchase programme by about 30 per cent. The programme envisaged an increment of about ¥80 trillion added to the monetary base annually, up from an existing ¥60–70 trillion. First in December 2015 and then in September 2016, the BoJ announced further modifications to its programme of quantitative and qualitative easing (QQE). The latest round of changes was motivated by the Bank's concern that negative interest rates, together with its asset purchase programme, via a flattening in the yield curve, posed risks to financial stability via their implications for bank profitability and pension funds' viability. Therefore the BoJ supplemented the QQE framework by "yield curve
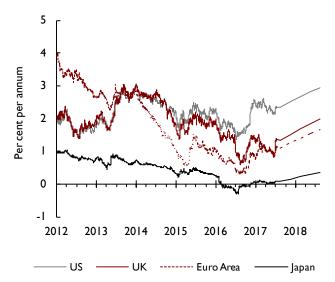
Table A3. Government revenue assumptions

	Average income tax rate (per cent)[a]			Effective corporate tax rate (per cent)			Gov't revenue (% of GDP)[b]		
	2016	2017	2018	2016	2017	2018	2016	2017	2018
Australia	14.8	15.2	15.1	25.7	25.7	25.7	33.6	34.3	34.6
Austria	31.1	31.2	31.3	21.8	21.8	21.8	42.7	43.2	42.5
Belgium	34.9	34.5	34.3	21.7	21.7	21.7	43.5	43.2	42.7
Canada	20.1	20.1	19.9	20.8	20.8	20.8	35.8	35.8	35.9
Denmark	35.5	33.9	33.8	17.9	17.9	17.9	46.4	45.6	44.5
Finland	33.2	33.4	32.8	23.1	23.1	23.1	47.1	46.8	46.1
France	31.6	31.6	31.6	32.7	32.7	32.7	45.5	45.5	45.6
Germany	29.8	29.7	29.7	19.4	19.4	19.4	41.9	42.2	41.9
Greece	23.4	23.6	23.5	13.5	13.5	13.5	45.5	41.8	39.6
Ireland	26.3	25.8	24.6	9.8	9.8	9.8	22.3	23.3	22.8
Italy	29.2	29.1	29.1	26.9	26.9	26.9	42.7	42.6	41.6
Japan	23.9	24.0	24.0	29.6	29.6	29.6	34.4	33.9	34.1
Netherlands	33.6	33.9	33.9	8.4	8.4	8.4	41.0	41.8	41.4
Portugal	22.8	22.4	22.4	20.1	20.1	20.1	39.7	38.1	37.9
Spain	25.4	24.9	24.9	16.4	16.4	16.4	37.7	37.5	36.9
Sweden	26.1	25.8	25.3	23.1	23.1	23.1	45.6	45.3	45.3
UK	22.6	22.9	22.7	13.1	12.3	12.1	35.8	35.5	35.1
US	19.1	19.0	19.0	29.0	29.0	29.0	30.2	30.4	30.5

Notes: (a) The average income tax rate is calculated as total income tax plus both employee and employer social security contributions as a share of personal income. (b) Revenue shares reflect NiGEM aggregates, which may differ from official government figures.

Table A4. Government spending assumptions[a]

	Gov't spending excluding interest payments (% of GDP)			Gov't interest payments (% of GDP)			Deficit projected to fall below 3% of GDP[b]
	2016	2017	2018	2016	2017	2018	
Australia	33.9	33.2	32.6	1.7	1.7	1.6	–
Austria	42.2	42.5	42.1	2.1	1.9	1.6	–
Belgium	43.3	42.8	42.0	2.9	2.6	2.2	2015
Canada	34.7	34.0	33.9	3.0	2.9	2.9	–
Denmark	46.0	46.3	45.5	1.3	1.3	1.1	–
Finland	47.9	46.5	45.7	1.1	0.9	0.8	2015
France	47.0	47.0	46.9	1.9	1.7	1.4	2018
Germany	39.6	39.6	39.2	1.5	1.6	1.4	–
Greece	41.6	38.5	35.8	3.2	2.8	2.4	2016
Ireland	20.6	20.7	20.8	2.3	2.0	1.9	2015
Italy	41.2	41.3	40.5	4.0	3.5	2.8	2015
Japan	37.3	37.0	36.7	1.7	1.5	1.3	–
Netherlands	39.6	39.4	39.3	1.1	0.9	0.8	–
Portugal	37.4	36.8	36.3	4.2	4.0	3.9	2016
Spain	39.4	38.6	37.5	2.8	2.2	1.6	2018
Sweden	44.2	43.9	43.8	0.6	0.5	0.4	–
UK	35.5	34.5	33.6	1.8	1.7	1.6	2016
US	31.6	31.5	31.1	3.6	3.7	3.8	2022

Notes: (a) Expenditure shares reflect NiGEM aggregates, which may differ from official government figures. (b) The deficit in Australia, Austria, Canada, Denmark, Germany, Netherlands and Sweden is not expected to exceed 3 per cent of GDP within our forecast horizon. In Japan the deficit is not expected to fall below 3 per cent of GDP within our forecast horizon.
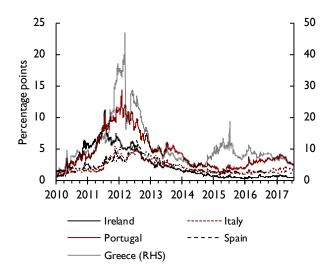
Figure A1. 10–year government bond yields

Source: Datastream and NIESR projections.

Figure A2. Spreads over 10–year German government bond yields

Source: Derived from Datastream series.

control": the Bank would regulate its asset purchases to target the 10-year government bond yield, initially at zero, so that it would control long-term as well as short-term interest rates. In late July 2017, the Bank of Japan announced that it was pushing back the projected timing for reaching its inflation target for a sixth time, to around April 2019 from a year earlier. At the same time, it kept its monetary stimulus programme unchanged.

Figure A1 illustrates the recent movement in, and our projections for, 10-year government bond yields in the US, Euro Area, the UK and Japan. Convergence in Euro Area bond yields towards those in the US, observed since the start of 2013, reversed at the beginning of 2014. Since February 2014, the margin between Euro Area and US bond yields started to widen, reaching a maximum of about 176 basis points in the end of December 2016, before somewhat stabilising at roughly 120 basis points since May 2017. In the second half of 2014 a wedge has opened between the US and UK government bond yields, which fluctuated between 20–30 basis points throughout 2015. From the beginning of 2016, the margin started to widen, and remained within the range of about 100–140 basis points since December 2016. Looking at the levels of 10-year sovereign bond yields in the second quarter of 2017, these have decreased slightly since the first quarter in the US and the UK – by a range of about 20–25 basis points, but remained largely unchanged in Japan and the Euro Area. Expectations for bond yields for 2017, compared with expectations formed just three months
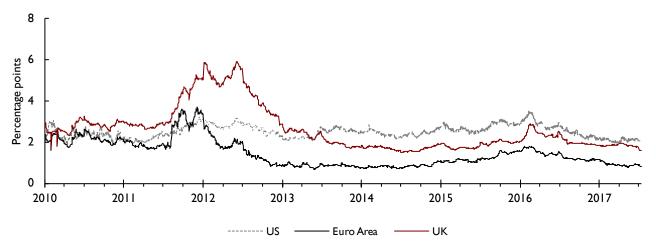
ago, are virtually unchanged for the US, UK, the Euro Area and Japan.

Sovereign risks in the Euro Area have been a major macroeconomic issue for the global economy and financial markets over the past five years. Figure A2 depicts the spread between the 10-year government bond yields of Spain, Italy, Portugal, Ireland and Greece over Germany's. Currently in our forecast, we have assumed spreads over German bond yields continue to narrow in all Euro Area countries.

Figure A3 shows the spreads of corporate bond yields over government bond yields in the US, UK and Euro Area. This acts as a proxy for the margin between private sector and 'risk-free' borrowing costs. Private sector borrowing costs rose more or less in line with the rise in government bond yields from the second half of 2013 to the second half of 2015, illustrated by the stability of these spreads in the US, Euro Area and the UK. Reflecting the tightening of financial conditions, corporate bond spreads widened at the beginning of 2016, but subsequently have narrowed somewhat barring the jump observed around the period of the UK's decision to leave the EU. In the second half of 2016 corporate bond spreads had been relatively stable in the UK, but had been on a declining trend in the US and the Euro Area, where private sector borrowing costs had risen less than the observed rise in risk-free rates. This trend is continuing in 2017 for the US, Euro Area and

Figure A3. Corporate bond spreads. Spread between BAA corporate and 10–year government bond yields
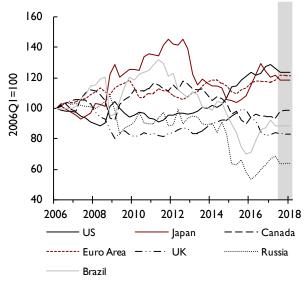

Source: Derived from Datastream series.

the UK. Our forecast assumption for corporate spreads is that they gradually converge towards their long-term equilibrium level.

Nominal exchange rates against the US dollar are generally assumed to remain constant at the rate prevailing on 14 July 2017 until the end of March 2018. After that, they follow a backward-looking uncovered-interest parity condition, based on interest rate differentials relative to the US. Figure A4 plots the recent history as well as our forecast of the effective exchange rate indices for Brazil, Canada, the Euro Area, Japan, UK, Russia and the US. The shifts in long-term interest differentials over the past three months have contributed to moderate depreciations of the US dollar against the Canadian dollar, the euro, and the renminbi, and to a moderate appreciation against the Russian rouble. In trade-weighted terms, the US dollar's value in late July was about 4 per cent lower than in late April and early May and 7 per cent below the 14-year peak reached last December. In the second quarter of this year, in effective terms, the yen and the euro have increased by a little more than 1 per cent. Over the same period, among the emerging market currencies, the largest movements in trade-weighted terms were a depreciation of the Brazilian real – by almost 4 per cent – and appreciation of the Mexican peso by about 10 per cent, reflecting receding expectations of US action against Mexican exports and the tightening of Mexican monetary policy.

Our oil price assumptions for the short term are based on those of the US Energy Information Administration
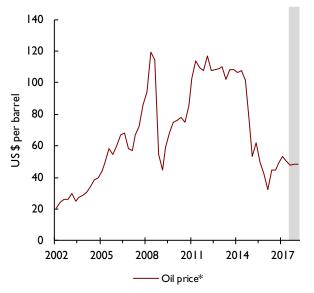
Figure A4. Effective exchange rates

Source: NiGEM database and NIESR forecasts. Weights based on 2010 goods and services trade shares.

(EIA), published in July 2017, and updated with daily spot price data available up to 14 July 2017. The EIA use information from forward markets as well as an evaluation of supply conditions, and these are illustrated in figure A5. Oil prices, in US dollar terms, have decreased by about 6 per cent between the second and the first quarters of this year. Projections from the EIA suggest an increase in prices towards the end of 2018 of about 5
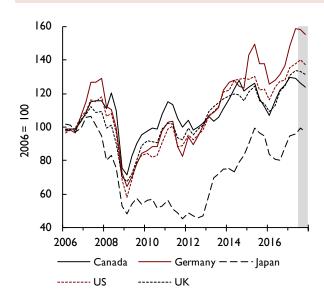
Figure A5. Oil prices

Source: NiGEM database and NIESR forecast.
Note: *Average of Dubai and Brent spot prices.

Figure A6. Share prices

Source: NiGEM database and NIESR forecast.

per cent, which is half of the rate expected three months ago. This will leave oil prices about $55 lower than their nominal level in mid-2014. Oil prices are expected to be about $48 and $53 a barrel by the end of 2017 and 2018, respectively.

Our equity price assumptions for the US reflect the expected return on capital. Other equity markets are assumed to move in line with the US market, but are adjusted for different exchange rate movements and shifts in country-specific equity risk premia. Figure A6 illustrates the key equity price assumptions underlying our current forecast. Movements in equity markets in the past three months have been mixed, increasing since the second quarter in the US and European economies and weakening in the countries where bond yields have risen and currencies have appreciated, for example in Canada.

Fiscal policy assumptions for 2017 follow announced policies as of 14 June 2017. Average personal sector tax rates and effective corporate tax rate assumptions underlying the projections are reported in table A3, while table A4 lists assumptions for government spending. Government spending is expected to continue to decline as a share of GDP between 2016 and 2017 in

the majority of Euro Area countries reported in the table. A policy loosening relative to our current assumptions poses an upside risk to the short-term outlook in Europe. For a discussion of fiscal multipliers and the impact of fiscal policy on the macroeconomy based on NiGEM simulations, see Barrell *et al.* (2012).

NOTES

1 With the exception of Chile, Iceland and Israel.
2 Interest rate assumptions are based on information available for the period to 14 July 2017, and do not include the 25 basis point cut in interest rate by the South African Reserve Bank on 20 July, 2017 or 100 basis point reduction by the Central Bank of Brazil on 26 July 2017.
3 For discussions of the short and long-run economic implications of the UK leaving the EU see Baker *et al.* (2016) and Ebell and Warren (2016), respectively.

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