Appendix A: Summary of key forecast assumptions by Graham Hacche, Iana Liadze and Rebecca Piggott

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 cut its benchmark interest rate by 50 basis points in two steps in 2016, before a further cut of 25 basis points in August 2017. The central bank of New Zealand reduced its benchmark rate by 75 basis points in three rounds in 2016, leaving it unchanged since. The People's Bank of China and the Reserve Bank of India both reduced their interest rates throughout 2015 by a total of 125 basis points each. While the People's Bank of China has left them unchanged since, the Indian central bank lowered its benchmark rate further by 50 basis points in two rounds in 2016, and then again by 25 basis points in August 2017. 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, 7-day reverse repurchase rate in August 2016, the interest rates were lowered in two further steps, by 25 basis points in each case. After almost a year without change, interest rates were unexpectedly cut by 25 basis points in August 2017 and then by a further 25 basis points the following month. 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 them 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 reduced its benchmark rate by 25 basis points to –0.75 per cent, while the Central Bank of Denmark cut 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 lowered its base rate by a further 25 basis points, to 9 per cent, in June and a further 50 basis

points in September. 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 and a further 25 basis points in September. Following the easing of inflationary pressures, the Central Bank of Brazil cut its interest rate by 100 basis points in May and a further 100 basis points in September – in total a reduction of 600 basis points since October 2016.

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 them further by 75 basis points in two rounds last year. In July the rate was cut by 25 basis points to 6.75 per cent. 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.[2]

In mid-June 2017, the US Federal Reserve raised its target range for the federal funds rate by 25 basis points to 1.00–1.25 per cent and left it unchanged since. 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. In October, as announced on 20 September, the Fed began the balance sheet normalisation programme it had described in June. The programme will gradually reduce the size of the Fed's balance sheet by limiting the reinvestments of the proceeds from maturing Treasury securities and principal payments from agency securities. In the fourth quarter of 2017, the declines in the Fed's security holdings will be capped at $6 billion a month for Treasury securities and $4 billion a month in agency securities. The two caps will rise gradually to $30 billion and $20 billion respectively.

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

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
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	0.70	–0.10	0.00	0.29	2.3	1.8	0.1	1.0	1.2
2018		1.77	1.31	–0.11	0.00	0.71	2.7	2.5	0.3	1.4	1.9
2019		2.41	1.80	–0.11	0.09	1.21	3.2	3.1	0.5	2.0	2.5
2020–24		3.31	3.15	0.35	1.46	2.40	3.9	3.9	1.3	3.2	3.6
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	0.79	–0.10	0.00	0.25	2.2	1.9	0.1	1.0	1.2
2017	Q4	1.33	1.00	–0.10	0.00	0.42	2.3	2.1	0.1	1.0	1.4
2018	Q1	1.51	1.12	–0.10	0.00	0.50	2.5	2.3	0.2	1.2	1.6
2018	Q2	1.69	1.24	–0.10	0.00	0.66	2.7	2.5	0.2	1.3	1.8
2018	Q3	1.86	1.37	–0.11	0.00	0.75	2.8	2.6	0.3	1.5	2.0
2018	Q4	2.04	1.49	–0.11	0.00	0.92	2.9	2.8	0.4	1.6	2.1
2019	Q1	2.19	1.61	–0.11	0.00	1.00	3.0	2.9	0.4	1.8	2.3
2019	Q2	2.34	1.73	–0.12	0.00	1.16	3.1	3.0	0.5	1.9	2.4
2019	Q3	2.48	1.86	–0.12	0.13	1.25	3.2	3.1	0.6	2.1	2.6
2019	Q4	2.63	1.98	–0.11	0.22	1.42	3.3	3.2	0.6	2.2	2.7

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
2014	3.6	−5.8	−5.6	3.0	1.5	1.4	2.4	7.3	1.112	105.8	0.754	0.607
2015	13.4	−11.3	−6.3	−5.8	−3.7	−3.9	−3.0	5.5	1.299	121.1	0.902	0.654
2016	5.3	0.2	15.3	4.9	2.4	2.4	2.9	−10.0	1.314	108.8	0.904	0.741
2017	0.5	2.0	−2.4	3.0	1.4	2.1	2.0	−5.3	1.293	112.0	0.887	0.776
2018	−2.0	2.7	−1.3	3.1	1.7	1.7	2.0	0.5	1.250	112.1	0.844	0.752
2019	−0.5	0.3	1.7	1.5	0.8	0.8	1.0	0.1	1.244	109.8	0.828	0.744
2016 Q1	1.6	4.2	6.6	2.6	1.3	1.1	1.4	−5.7	1.323	115.2	0.908	0.699
2016 Q2	−1.6	2.1	5.7	1.0	0.5	0.7	0.6	−1.6	1.289	107.9	0.886	0.697
2016 Q3	1.2	−1.2	5.9	0.3	0.0	0.4	0.0	−7.9	1.310	102.4	0.896	0.762
2016 Q4	3.6	−0.6	−4.2	0.0	−0.1	0.1	0.1	−2.6	1.333	109.5	0.927	0.805
2017 Q1	1.1	−0.1	−2.9	−0.6	−0.3	−0.2	−0.2	0.9	1.339	113.6	0.939	0.807
2017 Q2	−2.6	0.0	0.9	1.1	0.6	0.7	0.7	1.1	1.330	111.1	0.909	0.781
2017 Q3	−3.2	5.2	−1.5	4.4	2.3	2.3	2.7	−1.8	1.254	111.0	0.851	0.764
2017 Q4	0.5	0.2	−1.4	0.5	0.3	0.2	0.4	1.5	1.252	112.5	0.847	0.753
2018 Q1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.252	112.5	0.847	0.753
2018 Q2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.252	112.5	0.847	0.753
2018 Q3	−0.1	0.1	0.4	0.4	0.2	0.2	0.2	0.0	1.250	112.0	0.843	0.751
2018 Q4	−0.1	0.1	0.4	0.4	0.2	0.2	0.2	0.0	1.249	111.4	0.840	0.749
2019 Q1	−0.1	0.1	0.4	0.4	0.2	0.2	0.3	0.0	1.247	110.8	0.835	0.747
2019 Q2	−0.2	0.1	0.5	0.4	0.2	0.2	0.3	0.0	1.245	110.2	0.831	0.745
2019 Q3	−0.2	0.1	0.5	0.4	0.2	0.2	0.3	0.0	1.243	109.5	0.826	0.743
2019 Q4	−0.2	0.1	0.5	0.4	0.2	0.2	0.3	0.0	1.241	108.8	0.821	0.741

experience a slowdown as a consequence of the vote to leave the EU.[3] At its August 2016 meeting, to mitigate the expected downturn, the MPC introduced monetary stimulus, 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. Alongside the reduction in the policy rate and the expansion in asset purchases, the Bank of England also introduced the Term Funding Scheme. Under this scheme banks and building societies were able to borrow central bank reserves at close to Bank Rate for a period of up to four years. The total loans made under this scheme amount to £88 billion. At the time of writing, financial markets expect the MPC to raise rates to 50 basis points in the next four months, and to 70 basis points in the second half of 2018. Our view is similar in that we expect removal of the August 2016 25 basis point cut towards the end of this year. Given that inflation is expected to exceed the BoE's target of 2 per cent for the next two years, we expect further 25 basis point increases in May and November next year. Bank Rate is expected to reach 2 per cent in the second half of 2021, this being the point at which the MPC is assumed to stop re-investing the

proceeds from maturing gilts it currently holds, allowing the Bank of England's balance sheet to shrink 'naturally'.

The central banks of the Euro Area, the European Central Bank (ECB) and Japan, the Bank of Japan (BoJ) have continued to expand their balance sheets.

The ECB, at its September 2017 meeting, left its interest rates and asset purchase programme unchanged, but indicated that at its next meeting, on 26 October, it would decide on the calibration of its instruments beyond 2017. The ECB is thus due to continue its net asset purchases of €60 billion a month until the end of December 2017; it is expected to announce on 26 October (before publication of this *Review*) a scaling down of its asset purchases in 2018.

The BoJ has left its policy parameters unchanged in recent months. In October 2014, it 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

Table A3. Government revenue assumptions

|	Average income tax rate (per cent)[a]			Effective corporate tax rate (per cent)			Gov't revenue (% of GDP)[b]		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
Australia	15.1	14.9	14.2	25.7	25.7	25.7	34.2	34.6	34.2
Austria	31.2	31.2	31.0	21.8	21.8	21.8	42.4	41.2	40.6
Belgium	34.5	34.3	33.5	21.7	21.7	21.7	43.1	42.6	42.4
Canada	19.9	19.8	19.8	20.8	20.8	20.8	35.6	35.6	35.5
Denmark	33.9	33.8	33.6	17.9	17.9	17.9	44.6	44.4	44.9
Finland	33.5	32.8	31.8	23.1	23.1	23.1	46.2	45.6	44.8
France	31.6	31.6	31.5	32.7	31.7	30.1	45.1	45.1	44.9
Germany	29.7	29.7	29.5	19.4	19.4	19.4	41.5	41.4	41.1
Greece	23.6	23.5	23.1	13.5	13.5	13.5	41.8	39.7	38.7
Ireland	25.8	24.6	23.5	9.8	9.8	9.8	23.2	22.8	22.5
Italy	29.1	29.1	28.9	26.9	26.9	26.9	42.3	41.3	40.6
Japan	24.1	24.1	24.0	29.6	29.6	29.6	33.9	34.0	34.1
Netherlands	33.9	33.9	33.3	8.4	8.4	8.4	41.7	41.6	41.4
Portugal	22.4	22.4	22.1	20.1	20.1	20.1	37.6	37.5	37.2
Spain	24.9	24.9	24.6	16.4	16.4	16.4	37.8	37.2	36.7
Sweden	26.0	25.8	24.8	23.1	23.1	23.1	45.1	45.3	45.2
UK	22.1	21.9	22.0	12.3	12.1	12.1	36.4	35.9	35.7
US	19.4	19.5	19.6	29.0	29.0	29.0	30.1	30.3	30.6

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]
	2017	2018	2019	2017	2018	2019	
Australia	33.8	33.3	32.8	1.6	1.5	1.4	–
Austria	41.2	40.2	39.8	1.8	1.5	1.4	–
Belgium	42.4	41.6	41.5	2.5	2.1	1.8	2015
Canada	34.2	34.0	34.0	2.8	2.8	2.8	–
Denmark	45.5	45.2	45.3	1.3	1.1	1.1	–
Finland	45.8	44.9	44.5	0.9	0.8	0.8	2015
France	46.6	46.3	45.9	1.7	1.4	1.3	2018
Germany	39.1	38.9	38.8	1.6	1.4	1.3	–
Greece	40.0	38.2	36.7	2.8	2.4	2.3	2016
Ireland	20.6	20.8	21.3	2.0	1.9	1.8	2015
Italy	40.9	40.4	39.8	3.5	2.8	2.4	2015
Japan	37.2	36.9	36.8	1.4	1.2	1.1	–
Netherlands	38.6	38.8	38.9	0.9	0.7	0.6	–
Portugal	36.3	35.9	35.6	4.0	3.7	3.4	2016
Spain	38.8	37.8	37.4	2.2	1.6	1.3	2018
Sweden	44.0	43.8	43.9	0.5	0.4	0.4	–
UK	34.5	33.5	32.5	2.2	2.2	2.1	2016
US	31.0	30.6	30.5	3.6	3.6	3.6	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
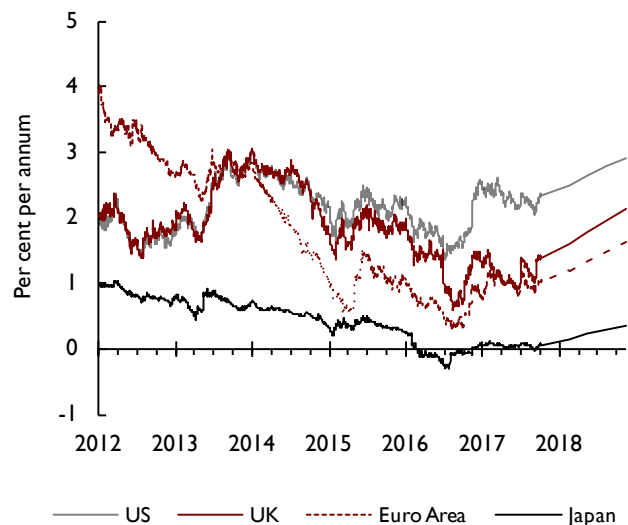
Source: Datastream and NIESR projections.

Figure A2. Spreads over 10–year German government bond yields
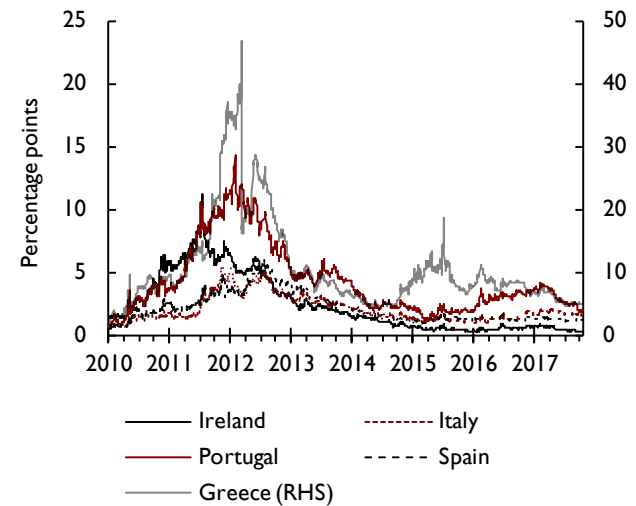
Source: Derived from Datastream series.

quantitative and qualitative easing (QQE). The latest round of changes includes 'yield curve control', which means that 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 at the end of December 2016. They subsequently narrowed, before widening again in recent months; in late October the gap between US and German 10-year yields was close to 200 basis points. In the second half of 2014 a wedge opened between US and UK government bond yields, which fluctuated between 20 and 30 basis points throughout 2015. From the beginning of 2016, the margin started to widen, and has remained within the range of about 90–140 basis points since December 2016. Looking at the levels of 10-year sovereign bond

yields in the third quarter of 2017, these have increased slightly since the second quarter in the UK – by about 20 basis points – but are largely unchanged in the US and Japan and the Euro Area. Expectations for bond yields for the end of 2017 are marginally lower as compared to expectations formed just three months ago. For the US and the Euro Area they are down by about 20–25 basis points, and by about 10 basis points for the UK and Japan.

Sovereign risks in the Euro Area were a major macroeconomic issue for the global economy and financial markets at times over the past five years. Figure A2 depicts the spread between 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

## Figure A3. Corporate bond spreads. Spread between BAA corporate and 10–year government bond yields
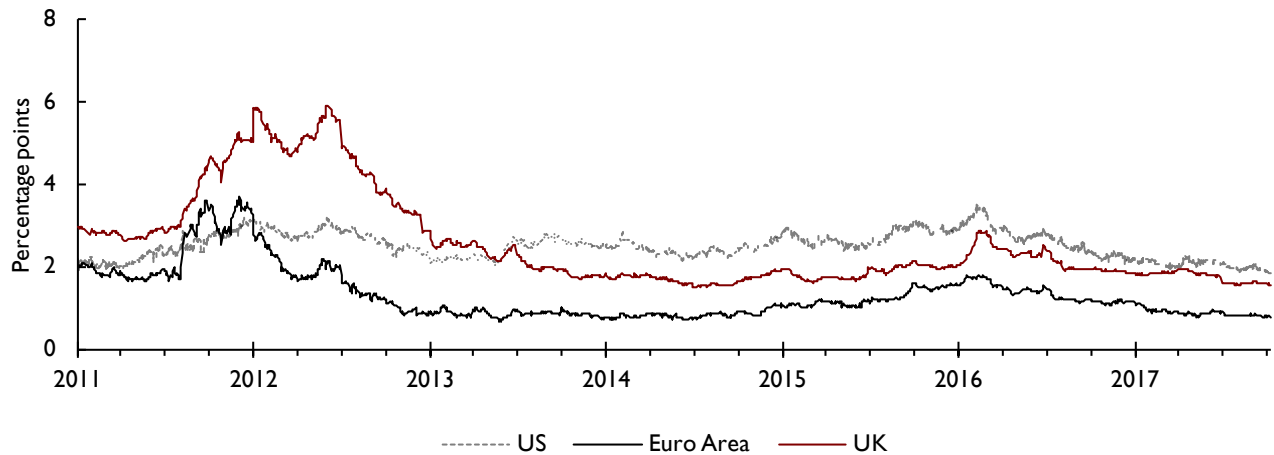
Source: Derived from Datastream series.

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 slightly declining trend in the US and the EA, 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, EA and 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 11 October 2017 until the end of June 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 Canada, the Euro Area, Japan, UK, and the US. Between the second and third quarters of 2017 the US dollar depreciated against the euro and the renminbi by about 6 and 3 per cent respectively, and appreciated against the Russian rouble by about 5 per cent. In trade-weighted terms, the US dollar's value was little changed in October from late July; remaining at 8 per cent below the 14-year peak reached late last year. Since the first quarter of this year, among the emerging market currencies, the largest movements in trade-weighted terms have been the appreciation of the Mexican peso by about 13 per cent, reflecting receding expectations of US action against Mexican exports and a tightening of Mexican monetary policy.

Figure A4. Effective exchange rates
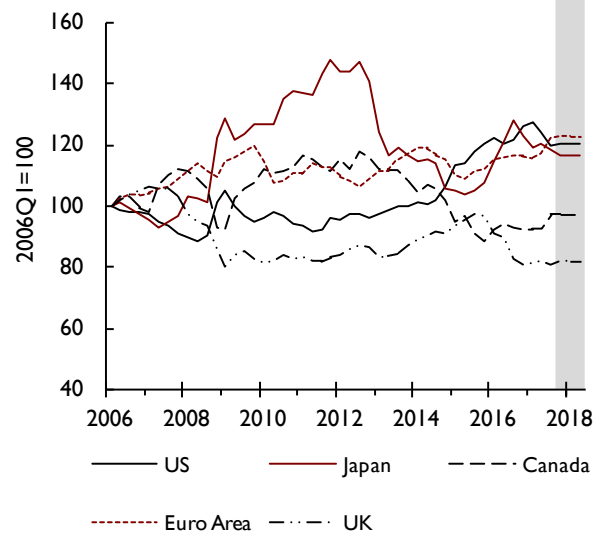
Source: NiGEM database and NIESR forecasts. Weights based on 2010 goods and services trade shares.

Our oil price assumptions for the short term are based on those of the US Energy Information Administration (EIA), published in October 2017, and updated with daily spot price data available up to 11 October 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,

Figure A5. Oil prices
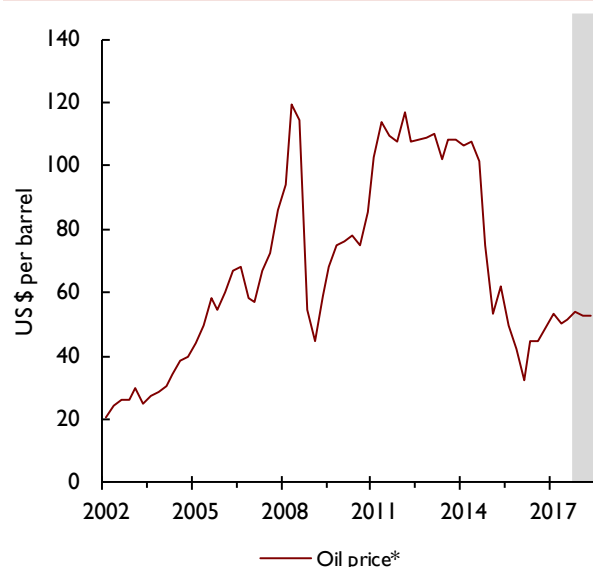
Source: NiGEM database and NIESR forecast.
Note: *Average of Dubai and Brent spot prices.

Figure A6. Share prices
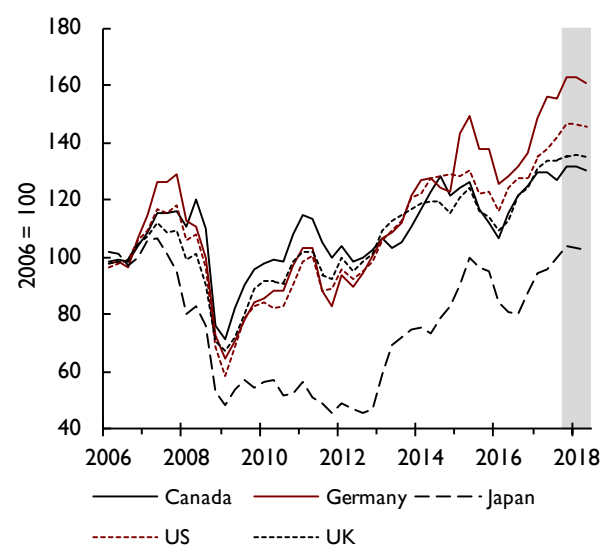
Source: NiGEM database and NIESR forecast.

have increased by about 3 per cent between the second and third quarters of this year. Projections from the EIA suggest about 8 per cent increase in prices towards the end of 2018, which still leaves oil prices about $52 lower than their nominal level in mid-2014. Expectations of oil prices by the end of 2017 and 2018 are about 12 and 6 per cent higher, respectively, compared to the expectation three months ago.

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. Between the second and third quarter equity prices in most countries continued their buoyant performance observed in the first half of this year. Stock market prices rose in the US, Japan, and the majority of European countries, but declined slightly, by about 2 per cent, in Australia and Canada.

Fiscal policy assumptions for 2017 follow announced policies as of 6 October 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 11 October 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 *et al*. (2016), respectively.

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