



March 2017

UK Economic Outlook

Special features on:

- Consumer spending prospects after Brexit
- Will robots steal our jobs? The potential impact of automation on the UK and other major economies



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Highlights and key messages for business and public policy

Key projections

	2017	2018
Real GDP growth	1.6%	1.4%
Consumer spending growth	2.0%	1.7%
Inflation (CPI)	2.3%	2.8%

Source: PwC main scenario projections

- UK economic growth held up better than expected in the six months following the Brexit vote, particularly as regards consumer spending. But there have been signs that growth may be beginning to ease in early 2017 as inflation has risen, squeezing household spending power.
- In our main scenario, we project UK growth to slow to around 1.6% in 2017 and 1.4% in 2018 due to slower consumer spending growth and the drag on business investment from ongoing political and economic uncertainty relating to the outcome of the Brexit negotiations. The Budget had little net impact on the growth outlook from a macroeconomic perspective.
- The weaker pound could also boost net exports, however, which should offer some support for overall GDP growth. The recent pick-up in the world economy should also help here.
- Service sector growth will slow but remain positive in 2017-18, but construction may suffer from lower investment levels. Some exporters will benefit from the weaker pound, but businesses serving domestic consumers are likely to see some slowdown in growth.
- The Bank of England will probably keep interest rates on hold in the short term, but the case for a rate rise could build later this year or, more likely, in 2018 if growth and inflation evolve broadly as we project.

Consumer spending growth to moderate, but housing and utilities share of total spending could rise to almost 30% by 2030

- Consumer spending growth is also projected to slow from previous strong rates, dropping to around 2% in 2017 and 1.7% in 2018 in our main scenario. This reflects the impact of a weaker pound in pushing up import prices and squeezing the real spending power of households, as well as expected slower jobs growth.
- There may be some offset to this from higher household borrowing in the short term, but there are limits to how much further this can increase as household spending may already exceed household disposable income this year.
- In the long run, we expect real consumer spending growth to average around 2% per annum, but the composition of this spending will change. The share of spending on housing and utilities could rise to close to 30% by 2030, while that on food, alcohol, tobacco and clothing declines over time.

Up to 30% of UK jobs could potentially be at risk from automation by the early 2030s, but there should be offsetting job gains elsewhere in the economy

- Our analysis suggests that around 30% of UK jobs could potentially be at high risk of automation by the early 2030s, lower than the US (38%) or Germany (35%), but higher than Japan (21%).
- The risks appear highest in sectors such as transportation and storage (56%), manufacturing (46%) and wholesale and retail (44%), but lower in sectors like health and social work (17%).
- However, in practice, not all of these jobs may actually be automated for a variety of economic, legal and regulatory reasons. Furthermore new automation technologies will both create some totally new jobs in the digital technology area and, through productivity gains, generate additional wealth and spending that will support additional jobs of existing kinds, primarily in services sectors that are less easy to automate.
- The net long term impact of automation on total UK employment is therefore unclear. Average pre-tax incomes should rise due to the productivity gains, but these benefits may not be evenly spread across income groups.
- There is a strong case for increased investment in lifelong vocational education and training to help people adapt to increased automation. Universal basic income schemes may also be considered, but suffer from potential problems in terms of affordability and adverse effects on work incentives.

1 – Summary

Recent developments

The UK economy held up well in the six months after the EU referendum, particularly as regards consumer spending. Growth was close to trend at 2% in the year to the fourth quarter of 2016.

UK growth continues to be driven by services, with manufacturing and construction seeing more volatile trends through the last year. There have, however, been signs from both retail sales data and business surveys that the resilience of consumer spending and services has started to falter in early 2017.

A key factor behind this recent moderation in retail spending has been an increase in the rate of consumer price inflation (CPI) from around zero on average in 2015 to 2.3% in the year to February 2017, as global commodity prices have picked up from lows in early 2016 and the effects of the weak pound after the Brexit vote have fed through supply chains.

Table 1.1: Summary of UK economic growth prospects

Indicator (% change on previous year)	OBR forecasts (March 2017)		Independent forecasts (February 2017)		PwC Main scenario (March 2017)	
	2017	2018	2017	2018	2017	2018
GDP	2.0	1.6	1.6	1.4	1.6	1.4
Consumer spending	1.8	0.9	1.7	1.0	2.0	1.7
Inflation (CPI)	2.4	2.3	2.6	2.8	2.3	2.8

Source: Office for Budget Responsibility (March 2017), Consensus Economics survey (average value of new forecasts made in February 2017 survey) and latest PwC main scenario.

Future prospects

As shown in Table 1.1, our main scenario is for UK GDP growth to decline gradually from 1.8% in 2016 to around 1.6% in 2017 and 1.4% in 2018 as the effects of the weaker pound on inflation and continued Brexit-related uncertainty feed through. Our views on growth are similar to the latest consensus forecasts but slightly lower than the new OBR forecasts in the March 2017 Budget (see Table 1.1). However, the broad pattern of gradually slowing growth over the next two years is common to most forecasts at present.

The largest effect of the vote to leave the EU is likely to be on real investment growth, which we now expect to be pushed down to around zero in 2017. This reflects major private sector projects being deferred or even cancelled due to uncertainties surrounding Brexit, although there should be some offset here from increased planned public investment. These uncertainty-related effects should fade eventually, but it will take time before clarity emerges on future UK-EU trading arrangements.

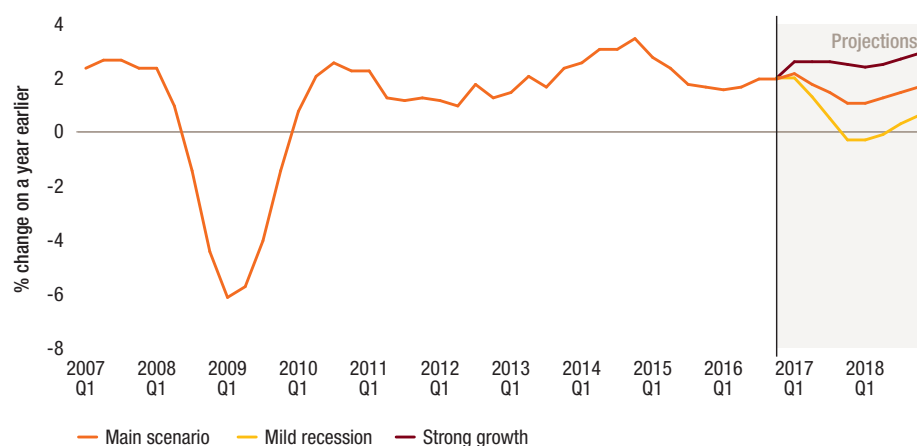
Consumer spending growth is also expected to moderate as inflation bites into real spending power, as we discuss in more detail below, though the weak pound should also have some offsetting benefits for net exports. A relatively strong global economy has also benefited UK exporters during the second half of 2016 and this seems likely to continue at least in the short term.

The Budget involved small net giveaways in 2017/18, notably on social care, but was broadly fiscally neutral in the medium term so its impact on the overall UK growth outlook will be minimal.

There are always uncertainties surrounding our growth projections and these are particularly marked following the vote to leave the EU, as illustrated by the alternative scenarios in Figure 1.1. There are still considerable downside risks relating to international developments (notably the French presidential elections in the short term and a possible US-led rise in global protectionism in the longer term) and the fallout from Brexit, but there are also upside possibilities if these problems can be contained. In our main scenario, we expect the UK to suffer a moderate slowdown not a recession, but businesses need to monitor and make contingency plans for potential downside risks.

Inflation could rebound to around 3% by early 2018 assuming the pound remains relatively weak and there is no repeat of past falls in global energy and food prices. Despite this, we expect monetary policy to remain on hold in the short term. In our main scenario, official interest rates are assumed to remain at current levels throughout 2017, but this will depend on how events develop. By early 2018, the case for a gradual rate rise could grow stronger if UK growth and inflation evolve broadly as projected in our main scenario.

Figure 1.1 – Alternative UK GDP growth scenarios



Sources: ONS, PwC scenarios

Consumer spending prospects after Brexit

Consumer spending has grown by an average of 2.4% per annum faster than inflation over the past four years, driving the overall UK economic recovery both before and after the Brexit vote.

As we discuss in detail in Section 3 of this report, this reflects rising employment levels, continued historically low interest rates, and a declining household savings ratio driven by higher borrowing and a strong housing market.

Looking ahead, we expect real household income growth to slow in 2017-18 as rising inflation squeezes household spending power and employment growth softens. Increased borrowing may help fill the gap, but there are limits to how far this can go on a sustainable basis.

As a result, in our main scenario we expect real consumer spending growth to moderate from around 3% in 2016 to around 2% in 2017 and 1.7% in 2018, although it could then pick up again to around 2% in 2020 and beyond assuming the Brexit negotiations go reasonably smoothly.

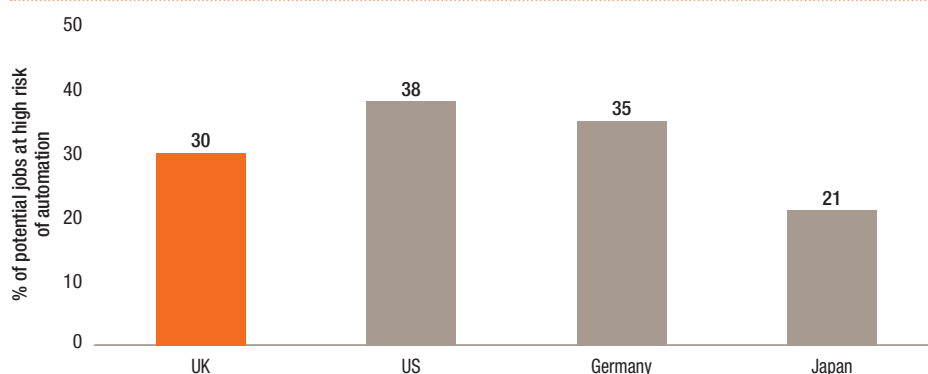
We project households will spend almost 30% of their budget on housing and utilities by 2030, up from around 25% in 2016. Spending on financial services and personal care (including self-funded social care) will also tend to increase relatively rapidly over time, while the share of total spending on food and clothing will tend to decline in the long run (see Figure 1.2).

Figure 1.2 – Historical trends and main scenario projections for household budget shares to 2030

1985 Rank		Spending Share	2016 Rank		Spending Share	2030 Rank		Spending Share
1	Housing & utilities	26.6%	1	Housing & utilities	25.4%	1	Housing & utilities	29.0%
2	Transport	12.6%	2	Transport	13.9%	2	Miscellaneous	15.0%
3	Food	12.2%	3	Miscellaneous	13.3%	3	Transport	12.4%
4	Miscellaneous	9.5%	4	Recreation & Culture	10.1%	4	Recreation & Culture	10.6%
5	Hotels and restaurants	8.8%	5	Hotels and restaurants	9.3%	5	Hotels and restaurants	9.4%
6	Recreation & Culture	7.9%	6	Food	8.2%	6	Food	5.7%
7	Clothing and footwear	6.0%	7	Clothing and footwear	5.8%	7	Furnishing	5.2%
8	Alcohol and tobacco	5.5%	8	Furnishing	4.8%	8	Clothing and footwear	4.3%
9	Furnishing	5.3%	9	Alcohol and tobacco	3.8%	9	Alcohol and tobacco	3.1%
10	Health	3.4%	10	Communication	2.0%	10	Health	1.9%
11	Communication	1.6%	11	Health	1.8%	11	Communication	1.8%
12	Education	0.6%	12	Education	1.6%	12	Education	1.6%

Sources: ONS for historical data, PwC for main scenario projections

Figure 1.3 – Potential jobs at high risk of automation by country



Sources: ONS; PIAAC data; PwC analysis

The impact of Brexit on the consumer will vary by category of spending. Our analysis shows that the food and clothing sectors are most exposed to the fall in the value of sterling since the Brexit vote due to a high reliance on imports. The hotel, restaurant, manufacturing and agricultural sectors are also heavily reliant on EU labour and so could be subject to disruption in the longer term if migration from the EU is significantly reduced after Brexit. Businesses need to prepare for these and other aspects of Brexit and make appropriate contingency plans.

Will robots really steal our jobs?

Our detailed analysis in Section 4 of this report suggests that around 30% of UK jobs could potentially be at high risk of automation by the early 2030s, lower than the proportion in the US or Germany, but higher than in Japan (see Figure 1.3).

We estimate that the risks could be highest in sectors such as transportation and storage (56%), manufacturing (46%) and wholesale and retail (44%), but lower in sectors like health and social work (17%).

For individual workers, the key differentiation factor is education (including vocational training). For those with just GCSE-level education or lower, the estimated potential risk of automation is as high as 46% in the UK, but this falls to only around 12% for those with undergraduate degrees or higher.

However, in practice, not all of these jobs may actually be automated for a variety of economic, legal and regulatory reasons. Furthermore new automation technologies in areas like AI and robotics will both create some totally new jobs in the digital technology area and, through productivity gains, generate additional wealth and spending that will support additional jobs of existing kinds, primarily in services sectors that are less easy to automate.

The net impact of automation on total employment is therefore unclear. Average pre-tax incomes should rise due to the productivity gains, but these benefits may not be evenly spread across income groups.

There is a strong case for increased investment in vocational education and training to help people of all ages to adapt to the challenge of automation. Given the pace of change, retraining and career shifts may need to become more frequent during what are likely to be longer average working lives. Universal basic income schemes may also be considered, but suffer from potential problems in terms of affordability and adverse effects on work incentives.

2 – UK economic prospects

Key points

- UK economic growth remained relatively strong at around 2% in the year to Q4 2016, with no immediate deceleration after the 'Brexit' vote.
- In our main scenario, we now project UK growth to slow from 1.8% in 2016 to around 1.6% in 2017 and 1.4% in 2018. The UK would avoid recession in this scenario, although risks to growth are still weighted somewhat to the downside given the uncertainties surrounding the Brexit negotiation process. Businesses need to make contingency plans for alternative outcomes to this process.
- Consumer spending growth is projected to slow from previous strong rates, dropping from 3% in 2016 to only around 2% in 2017 and 1.7% in 2018 in our main scenario. This reflects a squeeze on household spending power from higher inflation as well as slower jobs growth.
- We also expect business investment growth to remain relatively subdued in 2017-18 due to uncertainty about the UK's future trading relationships with the EU and other geopolitical uncertainties.
- The weaker pound should boost net exports, however, together with the gradual strengthening of the world economy we have seen over the past year.
- We expect growth in the services sector to slow but remain positive in 2016-17. The construction sector will suffer the most from lower investment levels, but some manufacturing exporters will benefit from the weaker pound.
- We project that London will remain the fastest growing region, but its pace of expansion could slow from around 2.5% in 2015 to an average of just under 2% in 2017-18. Other regions are projected to see average growth in 2017-18 of around 1-1.5%, and we do not predict negative growth in any region in either 2017 or 2018 in our main scenario.
- The Bank of England is likely to keep monetary policy on hold in the short term, but rate rises could come back on to the agenda next year in our main scenario.
- The Budget saw small net giveaways in 2017/18, but the overall stance of fiscal policy will continue to tighten gradually over the following years based on previously announced tax and spending plans.

Introduction

In this section of the report we describe recent developments in the UK economy and review future prospects. The discussion covers:

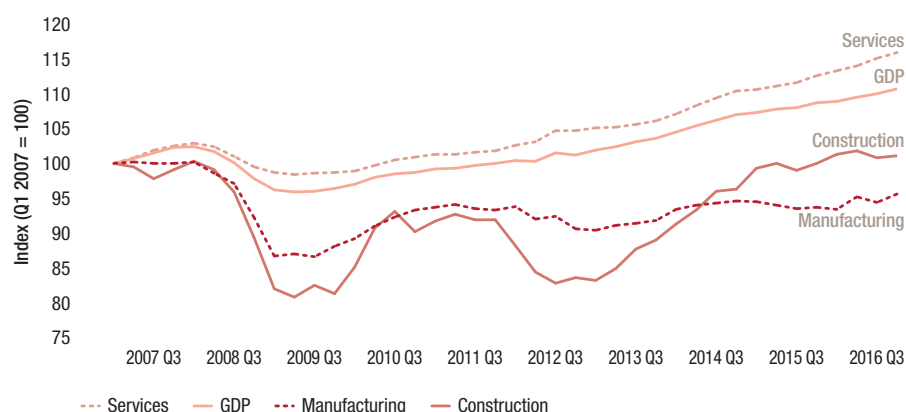
Section 2.1	Recent developments and the initial impact of Brexit
Section 2.2	Economic growth prospects after Brexit: national, sectoral and regional
Section 2.3	Outlook for inflation and real earnings growth
Section 2.4	Monetary and fiscal policy options
Section 2.5	Summary and conclusions.

2.1 – Recent developments and the immediate impact of Brexit

UK economic growth slowed from around 3% in 2014 to an estimated 1.8% in 2016. However, growth held up well in the second half of 2016, despite the vote for the UK to leave the EU ('Brexit') in June 2016. This was due in particular to the resilience of consumer spending in 2016, although there have been some tentative signs of this softening in early 2017.

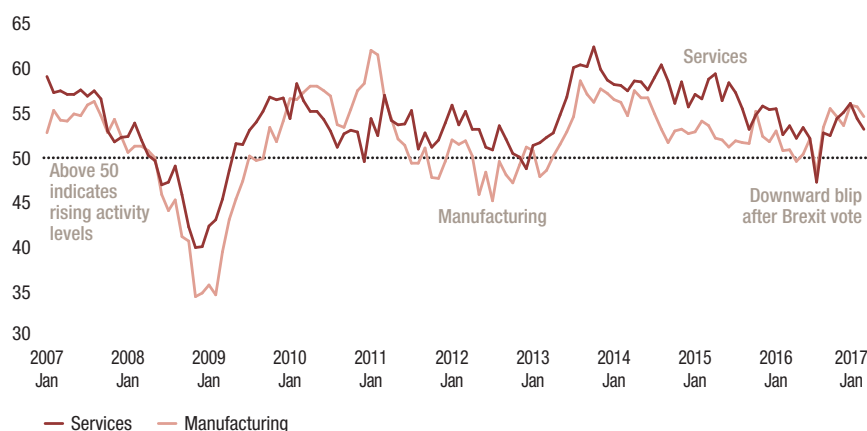
The general pattern, as shown in Figure 2.1, has been for services sector growth to remain relatively strong and steady, while growth in manufacturing and construction has been both weaker on average and more volatile. The purchasing managers' indices (PMIs) for services and manufacturing both saw impressive recoveries from the immediate post-referendum shock seen in July, but have dropped back somewhat in early 2017, particularly for services (see Figure 2.2). The construction PMI also bounced back in the autumn but has weakened somewhat in recent months.

Figure 2.1 – Sectoral output and GDP trends



Source: ONS

Figure 2.2 – Purchasing Managers' Indices of business activity

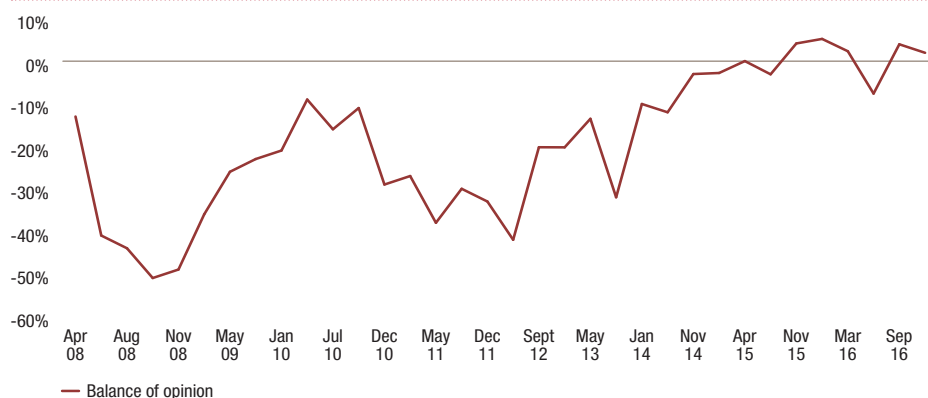


Sources: Markit/CIPS

Consumer confidence also suffered a dip immediately after the referendum, with the net balance according to PwC's regular survey (see Figure 2.3) falling to -8% in July, the first negative reading for almost a year. However, consumer confidence then bounced back strongly in September as the immediate shock of the Brexit vote faded, although it did fall back a little in December. A similar pattern has been seen in retail sales data, which was relatively strong between July and November, but weakened somewhat in December and January as inflation rose.

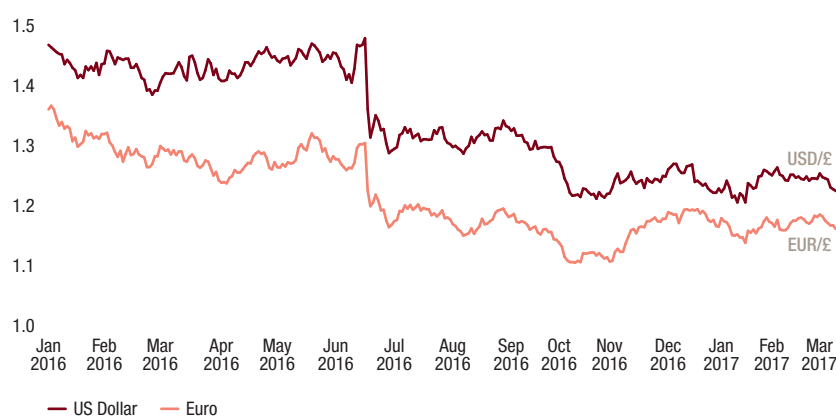
Following the vote to leave the EU, the pound fell sharply in value against both the dollar and the euro and has generally remained weak ever since despite short-term volatility (see Figure 2.4). The weaker pound will help UK exporters (including tourist flows into the UK), but will tend to push up import prices, which will ultimately feed through into a squeeze on consumers, alongside other factors such as the rise in global commodity prices from their lows in early 2016. The rise in headline consumer price inflation to 2.3% in February 2017 shows how inflationary pressures have already fed through to consumers and this is likely to continue through at least the next year, as we discuss further in Section 2.3 below.

Figure 2.3 – Consumer confidence: net balance expecting rising household disposable income over next 12 months



Sources: PwC Consumer Survey

Figure 2.4 – US dollar and euro exchange rates against the pound



Source: Bank of England

2.2 – Economic growth prospects after Brexit: national, sectoral and regional

We have continued to revise our growth projections for the UK based on the economic data that have been released since the vote to leave the European Union. Since the last UK Economic Outlook report in November, we have revised estimated growth in 2016 up from 1.2% to 1.6%. This reflects the relatively encouraging economic news that has emerged since mid-2016, but we still expect some drag on growth this year from rising consumer prices and an uncertain environment for business investment while the Brexit negotiations proceed. This means that below trend growth is also expected to persist into 2018, when our main scenario is for GDP growth of 1.4% as shown in Table 2.1. Our projections are similar to the latest consensus of independent forecasters, although slightly less optimistic than the OBR forecasts in the Budget. But the broad profile of gradually slowing growth over the next few years due to Brexit-related effects is common across most forecasters at present.

Overall, we expect growth to slow in 2017-18 but not to fall into recession, with the economy starting a gradual recovery later in 2018 on the assumption of no major adverse global shocks. We also assume here that Brexit negotiations proceed reasonably smoothly, leading to the expectation that the UK will avoid an extreme ‘hard Brexit’ where it falls out of the EU in 2019 without any trade deal or transitional arrangement, so reverting to WTO rules.

Table 2.1: PwC main scenario for UK growth and inflation

% real annual growth unless otherwise stated	2016	2017	2018
GDP	1.8%	1.6%	1.4%
Consumer spending	3.1%	2.0%	1.7%
Government consumption	0.8%	0.6%	0.7%
Fixed investment	0.5%	0.0%	0.7%
Domestic demand	1.6%	1.1%	1.3%
Net exports (% of GDP)	-0.4%	0.4%	0.0%
CPI inflation (%: annual average)	0.7%	2.3%	2.8%

Sources: ONS estimates for 2016, PwC main scenario projections for 2017-18. Note that domestic demand growth and the contribution from net exports does not sum to overall GDP growth in 2016 due to additional statistical adjustments by the ONS. In 2017 and 2018 any difference is much smaller and due largely to rounding.

We assume here that monetary policy remains supportive (as discussed further in Section 2.4 below) and that tax and spending plans are as set out in the Budget.

Consumer spending growth remained strong at around 3% in 2016, but we expect this to slow to around 2% in 2017 and 1.7% in 2018. As discussed in detail in Section 3 below, this primarily reflects higher inflation squeezing real spending power, as well as softening jobs growth.

The other main drag on GDP growth will come from continued subdued business investment, giving ongoing uncertainties about the exact outcome of the Brexit negotiations, even if we assume here that worst case ‘WTO scenarios’ are avoided. While we assume some kind of free trade agreement will eventually be reached with the EU, this will take time and (given the need to increase control over immigration) will involve some reduction in access to the EU single market relative to the current position. Even if tariffs on goods are largely avoided, non-tariff barriers are likely to increase for both goods and services.

Government consumption growth will be less affected than business investment, but is likely to remain moderate in line with Budget plans. Public sector investment is planned to be stronger, however, which should partly offset the expected weakness in private investment in 2017-18.

UK net exports should move in a more favourable direction this year as import demand weakens and the fall in the pound helps exports and import substitutes to become more competitive. We therefore expect a positive contribution from net exports to GDP in 2017, but this may become more neutral again in 2018.

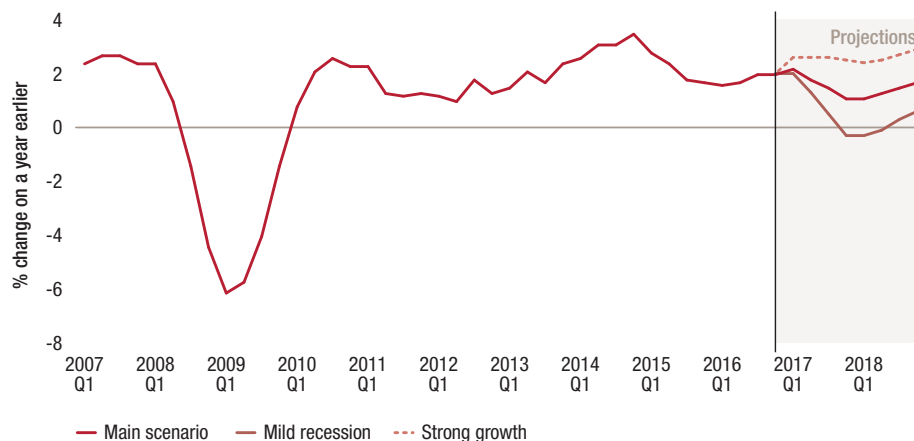
Overall, our growth projections are broadly similar to the latest average of independent forecasters, but slightly more cautious than those of the Bank of England and the OBR. But all economic projections are subject to particularly large uncertainties at present after the shock of the Brexit vote.

Alternative growth scenarios – businesses need to make contingency plans

To reflect these uncertainties, we have also considered two alternative UK growth scenarios, as shown in Figure 2.5.

- Our ‘strong growth’ scenario projects that the economy will expand by over 2% this year and over 3% in 2018. This is a relatively optimistic scenario which assumes that good early progress is made in UK-EU negotiations and there are strong favourable trends in US and euro area growth in 2017-18.
- On the other hand, our ‘mild recession scenario’ sees UK GDP growth fall into negative territory later in 2017 as the global outlook worsens and there is little progress in early negotiations with the EU, suggesting that the UK may have to fall back on WTO rules with consequent imposition of tariffs on trade with the EU. This would deepen and prolong the period of uncertainty around the outcome of Brexit, reducing investment, jobs and growth. Even in this downside case, however, we are only projecting a mild technical recession, not the deep downturn seen after the global financial crisis, when UK GDP fell by around 6% from peak to trough.

Figure 2.5 – Alternative UK GDP growth scenarios



Sources: ONS, PwC scenarios

We do not believe that either of these two alternative scenarios is the most likely outcome, but they are certainly possible and, at present, risks to growth still appear to be weighted somewhat to the downside given the political and economic uncertainties related to Brexit (and, in the short term, also the French presidential elections, which are due to be completed in early May). Businesses would therefore be well advised to make appropriate contingency plans for such less favourable outcomes, but without losing sight of the more positive possibilities for the UK economy should these downside risks not materialise. Looking further ahead, these also include the scope for longer term trade expansion with non-EU trading partners like China and India, as discussed in more detail in the November issue of this report.

More generally, companies should consider making detailed contingency plans for the potential impact of Brexit¹ on all aspects of their businesses, covering the kind of questions listed in Table 2.2.

¹ For more material on the potential impact of Brexit on your business, please see our EU Referendum hub here: <http://www.pwc.co.uk/the-eu-referendum.html>

Table 2.2: Key issues and questions for businesses preparing for Brexit

Issues	Implications	Questions
Trade	The EU is the UK's largest export partner, accounting for around 44% of total UK exports – leaving the EU is likely to make trade with EU more difficult.	<ul style="list-style-type: none"> How much do you rely on EU countries for revenue growth? Have you reviewed your supply chain to identify the impact of tariffs on your procurement? Have you identified which third party contracts would require a renegotiation in the event of a Brexit?
Tax Contributions	The UK would gain more control over VAT and some other taxes. Brexit could also open the door to new tax initiatives within the EU that the UK might currently have sought to block.	<ul style="list-style-type: none"> Have you thought about the impact of potential changes to the UK and EU tax regimes after Brexit? Have you upgraded your systems to deal with a significant volume of tax changes?
Regulation	The UK is subject to EU regulation. Brexit may mean less red tape. It could also mean that UK businesses could have to adapt to a different set of regulations, which could be costly.	<ul style="list-style-type: none"> Have you quantified the regulatory impact of Brexit to keep your stakeholders up-to-date? How flexible is your IT infrastructure to deal with potential changes to Data Protection laws? How ready is your compliance function to deal with potential new reporting requirements arising from Brexit?
Sectoral effects	The UK is the leading European financial services hub, which is a sector that could be significantly affected by Brexit. Other sectors which rely on the EU single market could also feel a strong impact.	<ul style="list-style-type: none"> Have you briefed potential investors on the impact of Brexit for your sector and organisation? How up-to-date are your contingency plans in place to deal with Brexit? Are you aware of the impact of illiquidity and volatility in financial markets on your capital raising plans?
Foreign direct investment	FDI from the EU makes up around 45% of the total stock of FDI in the UK. Brexit could put this inbound investment at risk.	<ul style="list-style-type: none"> How much do you rely on FDI for growth? Have you considered alternative sources of funding aside from banks? How are your competitors responding to the risk of Brexit?
Labour market	The UK may change its migration policies. Currently EU citizens can live and work in the UK without restrictions. Businesses will need to adjust to any change in this regime.	<ul style="list-style-type: none"> How reliant is your value chain on EU labour? Have you communicated with your UK based employees who are nationals of other EU countries? What advice should you give them on registering for UK residency? Has your compliance function considered the additional cost of hiring EU labour after Brexit? Could changes in access to EU labour increase the case for automation?
Uncertainty	Uncertainty has increased since the referendum and this may continue through the Brexit negotiation period.	<ul style="list-style-type: none"> How well prepared are you to manage future volatility in the Sterling exchange rate as Brexit negotiations proceed? Have you communicated your approach to Brexit to your key stakeholders, customers and suppliers? Is your organisation ready for a worst-case scenario where there is a prolonged period of uncertainty and/or a 'hard Brexit'?

Source: PwC assessment

Service sector growth has slowed, but manufacturing exports could be stronger in 2017

The sector dashboard in Table 2.3 shows latest ONS estimates of growth rates for 2016 along with our projected growth rates for 2017 and 2018 for five of the largest sectors within the UK economy. The table also includes a summary of the key issues affecting each sector.

The outlook is clearly stronger for private non-financial services than for other sectors, but all are likely to be negatively affected to some degree by leaving the EU. Construction may be hardest hit due to its reliance on large scale private sector investment projects that may be particularly prone to be delayed or even cancelled due to uncertainty following the vote to leave the EU, although public sector

investment is being increased to partly offset this. Manufacturing exporters will gain from the weaker pound and stronger global growth, however, so this sector may show a modest revival this year.

Financial services companies could also be affected by any loss of access to EU markets, notably through the possible loss of 'passporting' rights for UK-based firms².

Table 2.3: UK sector dashboard

Sector and GVA share	Growth			Key issues/trends
	2016	2017	2018	
Manufacturing (10%)	0.7%	1.3%	1.0%	<p>Manufacturing PMI reached its highest level for over two years in December, before falling back slightly in January and February</p> <p>Capital goods manufacturers vulnerable to a fall in investment after vote to leave EU</p> <p>But exporters should gain from weaker pound</p>
Construction (6%)	1.5%	0.1%	0.9%	<p>The construction sector saw negative growth in the third quarter but a small increase in the fourth quarter</p> <p>The latest PMI survey data suggested continued modest growth in early 2017, though housebuilding has slowed recently</p> <p>Increased public investment may partly offset weaker private construction activity due to Brexit-related uncertainty</p>
Distribution, hotels & restaurants (14%)	5.0%	3.3%	1.7%	<p>ONS figures show that retail sales were strong up to November but weakened in December and January</p> <p>A weaker pound will hit real spending by domestic consumers as import prices rise, but tourists to the UK will benefit from the weak pound and could spend more here as a result</p>
Business services and finance (32%)	2.7%	1.6%	1.7%	<p>The financial sector remains particularly concerned about the possible implications of Brexit, especially if a "hard Brexit" occurs with the loss of EU passporting rights.</p> <p>Some banks may be preparing to relocate some functions abroad due to Brexit, though we have not seen large moves yet</p> <p>For the moment, however, household borrowing remains relatively robust, supporting retail banks</p>
Government and other services (23%)	1.6%	1.0%	0.8%	<p>Philip Hammond announced some new infrastructure investments in November, but public services will continue to face real-term cuts for the next few years as confirmed in the Budget</p>
Total GDP	1.8%	1.6%	1.4%	

Sources: ONS for 2016 estimates, PwC for 2017 and 2018 main scenario projections and key issues.

These are five of the largest sectors but they do not cover the whole economy – their GVA shares only sum to around 85% rather than 100%.

² The potential impact of Brexit on financial services was considered in detail in our April 2016 report for TheCityUK, which can be accessed here: <http://www.pwc.co.uk/industries/financial-services/insights/leaving-the-EU-implications-for-the-UK-financial-services-sector.html>

Figure 2.6 – PwC main scenario for output growth by region in 2017 and 2018



Source: PwC analysis

Regional prospects: all parts of the UK likely to see some moderation in growth due to Brexit, but none should fall into recession in 2017 or 2018

London is expected to continue to lead the regional growth rankings in 2017, expanding by around 2% as shown in Figure 2.6, although this is down from around 3% in 2015. Most other regions are expected to expand at rates closer to the UK average of around 1.5%, but Northern Ireland is expected to lag behind somewhat with growth of around 1.2%.

Growth is expected to decelerate a little further in all regions in 2018 as the UK continues to feel the effects of Brexit-related uncertainty. We do not, however, project negative growth in any region in our main scenario. Growth in London might fall to around 1.8% in 2018, while Northern Ireland may again lag behind the rest of the UK with growth of just under 1%.

It is important to note that regional output data are published on a much less timely basis than national data. As a result, the margins of error around these regional output projections are even larger than for the national growth projections, so they can only be taken as illustrative of broad directional trends.

2.3 – Outlook for inflation and real earnings growth

Consumer price inflation (CPI³) picked up from 0.6% in August to 2.3% in the year to February 2017. Higher import prices are beginning to feed through to consumers because of the significant and persistent fall in sterling since the Brexit vote on 23 June. In addition to this, an increase in oil prices since their low point in early 2016 will push up costs for energy and transport, helping push inflation higher (though oil prices remain a long way below mid-2014 peaks).

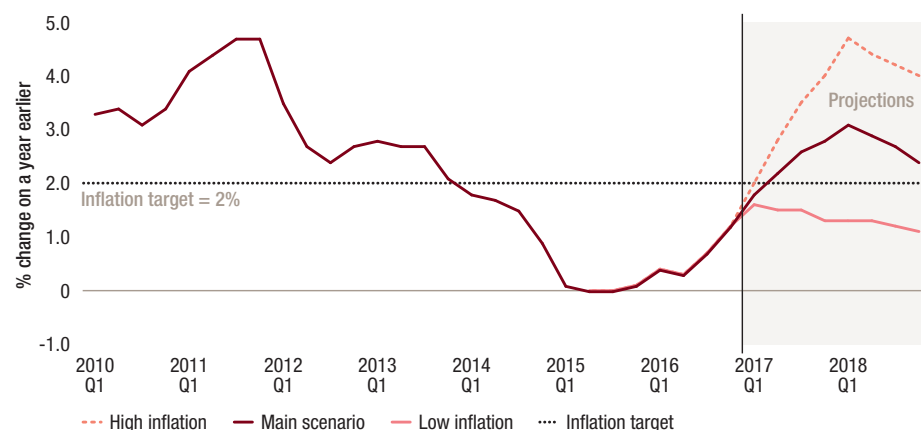
Over the course of 2017 we therefore expect CPI inflation to rise well above the Bank of England's 2% target rate, perhaps peaking at around 3% in early 2018 in our main scenario (see Figure 2.7) before easing back to around 2.5% by the end of next year as the effects of earlier import price rises fall out of the 12-month inflation calculation. Annual average rates of inflation in our main scenario would be around 2.3% this year and around 2.8% next year, but this disguises significant movements within these years.

Alternative inflation scenarios

In our main scenario we are projecting an average consumer price inflation rate of 0.6% in 2016 and 2.3% in 2017, which we have revised up since our last UK Economic Outlook report in the face of the recent weakness of the pound. By the fourth quarter of 2017, inflation could average around 2.7%, well above the Bank of England's 2% target rate (see Figure 2.7).

There is considerable uncertainty over how far and fast inflation will rise, however, and we therefore also present two alternative scenarios for UK inflation in Figure 2.7:

Figure 2.7 – Alternative UK inflation (CPI) scenarios



Sources: ONS, PwC scenarios

Figure 2.8 – CPI inflation vs average earnings growth



Sources: ONS, PwC analysis

- In our **'high inflation' scenario** we project inflation to rise to over 4% in 2018 as a result of potential further falls in the pound and a possible pick-up in global commodity prices if other economies grow more strongly and/or oil supply is constrained by producers.
- In our **'low inflation' scenario**, by contrast, the UK and global economies weaken by more than expected in our main scenario in the aftermath of Brexit, while global commodity prices fall back sharply over the next year. In this case, UK inflation could remain below target.

3 The ONS is due to switch to CPIH as its main inflation indicator from March 2017, despite some continuing methodological concerns about the reliability of the way that CPIH captures owner occupied housing costs through estimates of equivalent market rents rather than actual outlays on mortgage payments. For this edition of UK Economic Outlook, we have stuck to CPI as our key inflation indicator but we may consider switching to CPIH in future if this becomes more widely used. In the long run, however, we would not expect significant differences between average inflation on these two measures (based on long-term historical averages).

As with our GDP growth scenarios, neither of these two alternative variants is as likely as our main scenario. But given recent volatility and uncertainty, businesses should plan for a broad range of outcomes after Brexit and risks to UK inflation do seem to be weighted to the upside at present (in contrast to risks to real GDP growth, which we think are still weighted somewhat to the downside).

Consumer price inflation exceeded earnings growth for six consecutive years following the onset of the 2008-9 recession, which was in marked contrast to pre-crisis norms. Positive real earnings growth resumed in 2015 and 2016 as consumer price inflation fell to close to zero, but nominal earnings growth in cash terms was still only just over 2%, which remains weak by historical standards.

There might be a gradual pick-up in earnings growth in 2017-18, but this is less clear after the vote to leave the EU. On the one hand, higher consumer price inflation due to the weaker pound could feed through into higher nominal earnings growth, but on the other hand this could be offset by weaker economic growth and so labour demand in 2017-18. Balancing these two effects, our preliminary projection is that earnings growth remains at moderate levels in 2017-18, with real earnings growth falling back to around zero in 2018, as shown in Figure 2.8. But there are considerable uncertainties around any such projections at present.

2.4 – Monetary and fiscal policy options

The Monetary Policy Committee (MPC) cut interest rates in August and announced an expansion of its quantitative easing (QE) asset purchase scheme, by £60bn for UK government bonds and up to £10bn for high quality corporate bonds.

Monetary policy has remained on hold since then and we would expect this to continue for at least the next few months as the MPC waits for more data on growth and inflation, as well as seeing how the Brexit negotiations develop. If the data evolve broadly in line with our main scenario, however, we might expect a very gradual rise in official interest rates to begin sometime in 2018.

The OBR revised down its 2016/17 public borrowing forecast significantly, but this was mostly due to one-off factors and shifts in the timing of revenues and spending that pushed some borrowing forward into 2017/18. The OBR's medium term view on both growth and borrowing was little changed from its last forecast in November. Accordingly, there was little change in the overall stance of fiscal policy, although the Chancellor did use some of the short-term borrowing undershoot to pay for an increase in social care and NHS spending to ease short term pressures in these areas.

Looking beyond the next two years, however, the Budget actually involved small net tax rises, but the macroeconomic impact of the changes will be minimal. Previous plans to cut current spending as a share of GDP were left broadly unchanged, with austerity set to continue well into the early 2020s, albeit proceeding at a markedly slower rate than planned by George Osborne in his 2015-16 Budgets.

2.5 – Summary and conclusions

UK economic growth remained relatively strong in the second half of 2016, increasing by around 2% in the year to the fourth quarter as consumer spending in particular remained resilient. But business investment was less strong last year (albeit volatile from quarter to quarter) and there have been some signs in early 2017 that higher inflation is starting to take its toll on retail sales growth. These less favourable trends seem likely to continue for the rest of 2017 and into 2018 assuming the outcome of the Brexit negotiations remains unclear and the pound continues to be relatively weak.

In our main scenario, we therefore project UK growth to slow gradually from around 1.8% in 2016 to around 1.6% in 2017 and 1.4% in 2018. This assumes no major new adverse shocks to the global or EU economies (e.g. from the French presidential election results in early May).

The main reason for this significant slowdown in UK growth is projected to be a downturn in business investment driven by continued uncertainty surrounding the negotiations to leave the EU, and a squeeze on real household spending power from rising inflation, which could reach around 3% by early 2018 in our main scenario, and a softening of jobs growth. But somewhat stronger net exports, helped by the weaker pound, should dampen the scale of the fall in overall GDP growth this year.

There are considerable uncertainties around any such projections at present, however, so businesses should stress test their business and investment plans against alternative economic scenarios and also review the potential wider implications of Brexit for all aspects of their operations.

3 – Consumer spending prospects after Brexit

Key points

- Consumer spending has grown by an average of 2.4% per annum faster than inflation over the past four years, driving the overall UK economic recovery both before and after the Brexit vote.
- This has reflected rising employment levels, continued historically low interest rates, and a declining household savings ratio driven by higher borrowing and a strong housing market.
- Looking ahead, we expect real household income growth to slow in 2017-18 as rising inflation squeezes household spending power and employment growth softens. Increased borrowing may help fill the gap, but there are limits to how far this can go on a sustainable basis.
- As a result, in our main scenario we expect real consumer spending growth to moderate from around 3% in 2016 to around 2% in 2017 and 1.7% in 2018.
- We project households will spend just under 30% of their budget on housing and utilities by 2030, up from around 25% in 2016. Spending on financial services and personal care will also tend to increase relatively rapidly over time, while the share of total spending on food and clothing will tend to decline in the long run.
- The impact of Brexit on the consumer will vary by category of spending. Our analysis shows that the food and clothing sectors are most exposed to the fall in the value of sterling since the Brexit vote due to a high reliance on imports. The hotel, restaurant, manufacturing and agricultural sectors are also heavily reliant on EU labour and so could be subject to disruption in the longer term if net migration from the EU is significantly reduced after Brexit (without a fully offsetting rise in non-EU net migration). Businesses need to prepare for these and other aspects of Brexit and make appropriate contingency plans.
- **real household disposable income (RHDI) growth**, which in turn is driven by trends in real income from employment, state benefits and pensions and other private income; and
- **changes in the household savings ratio**, which are particularly influenced by the relative indebtedness of households and wealth effects (e.g. from house price changes).

The discussion is structured as follows:

Section 3.1	Recent trends in household disposable income
Section 3.2	Future trends in household disposable income
Section 3.3	Household savings ratio: trends and projections
Section 3.4	Alternative scenarios for consumer spending growth to 2030
Section 3.5	Projected consumer spending growth by category
Section 3.6	Potential impact of Brexit on key consumer-focused sectors
Section 3.7	Summary and conclusions.

Introduction

Consumer spending accounts for more than two thirds of UK GDP and is therefore the most important driver of UK economic growth. More recently, strong consumer spending has played a central role in the resilience of the UK economy both before and after the EU referendum, but will this robust growth continue in 2017 and beyond? Which areas of consumer spending might grow the fastest over the next decade? And how is Brexit expected to affect key consumer sectors?

To answer these questions, we have looked at past trends and future prospects for the two key determinants of household spending growth:

1 This article was written by Barret Kupelian, Duncan Mckellar and John Hawksworth of PwC's economics practice.

3.1 – Recent trends in household disposable income

The ONS defines household disposable income as the sum of earnings, state transfers (e.g. social security benefits) less direct taxes (mainly income tax and national insurance), and other net income accruing to households (e.g. from interest, dividends, rent and other transfers).

Table 3.1 show how the key drivers of household expenditure have changed over the four years to Q3 2016². This is the period which saw the UK economy start to recover on a more sustained basis. Real growth rates in the final column of the table have been calculated by deflating the nominal growth rates using the household expenditure deflator (which over this period averaged 1.4% per annum).

The most notable feature of this analysis is that household disposable income grew on average by around 1.4% per annum in real terms, while household expenditure grew a full percentage point faster at 2.4% per annum. This was associated with a decrease in the household savings ratio (adjusted to exclude changes in pension entitlements) from 4.2% to 0.6% over this period.

Table 3.1 shows that real pre-tax earnings grew by an average of 2.4% per annum over the period supported by a real increase in total wages and salaries of 1.9% per annum. This partly reflects the fact that the total number of people in employment rose by almost 2 million between Q3 2012 and Q3 2016, as well as a recovery in average real earnings per employee in 2015-16 as inflation fell sharply.

Table 3.1: Key drivers of real household disposable income

	£ billion		Average growth rates per annum		
	2012 Q3	2016 Q3	Nominal	Deflator	Real
Wages and salaries	176	200	3.3%	1.4%	1.9%
Household share of gross operating profits	63	77	5.1%	1.4%	3.7%
Pre-tax earnings	238	277	3.8%	1.4%	2.4%
Income tax paid	-48	-54	3.4%	1.4%	2.0%
National insurance contribution by workers	-32	-36	3.1%	1.4%	1.7%
Post-tax earnings	158	186	4.1%	1.4%	2.7%
Social security benefits	82	88	2.0%	1.4%	0.6%
Post-tax earnings and benefits	240	274	3.4%	1.4%	2.0%
Net property income received (interest, dividends, rent etc.)	36	39	1.9%	1.4%	0.5%
Net current transfers	10	7	-8.8%	1.4%	-10.2%
Household disposable income	286	320	2.8%	1.4%	1.4%
Adjustment for change in pensions entitlements	16	16	0.0%	1.4%	-1.4%
Available household resources	302	336	2.7%	1.4%	1.3%
Memo: Household expenditure	274	318	3.8%	1.4%	2.4%

Sources: PwC analysis of ONS data

Note*: Totals may not correspond exactly to the sum of sub-categories due to rounding

2 This is the last period for which detailed household income data were available at the time of writing.

Profits earned by the self-employed and owners of small businesses grew even more strongly, at an average real rate of around 3.7% per annum over the four years. This reflects a shift towards self-employment and small business start-ups since around 2010.

However, Table 3.1 also shows that there are three areas that have dampened growth in real household disposable income over the period:

- **Social security benefits:** the modest overall real average rate of growth of 0.6% per annum for this item disguises the divergence between benefits paid to those of working age and those to the retired. Specifically, total state pensions have grown at a real annual average rate of 3.3% during the 2012-2016 period contrasting with an average real decrease in total personal tax credits and equivalents of around 3% per annum over the same period³. In part the latter trend is explained by the improving employment situation in the UK since 2012, which has reduced the number of people receiving working age benefits.

- **Net property income:** this category of income has also seen relatively slow real growth (0.5% per annum), due in particular to the fact that interest rates on savings have remained at record lows, although of course this also applies to loan interest rates.
- **Net current transfers:** this income category includes transfers to consumers in the form of financial gifts, and some insurance claims, but excludes government transfers. These transfers have decreased sharply since Q3 2012 largely as a result of falling insurance claims over the period (from a high of £6.4bn in 2013 to just under £5bn in 2015 in nominal terms). However, this is a comparatively small element of household income (around 2% of the total) so the effect on overall household income growth is not that great.

The final row in Table 3.1 shows that total real household resources grew by 1.3% per annum after taking into account the change in the adjustment of pension fund entitlements. However, such changes in pension values are unlikely to be perceived by most households as usable income, so we prefer to exclude this from the analysis by focusing on an 'adjusted household savings ratio' defined as the difference between household disposable income and expenditure as a % of disposable income. This is lower than the standard ONS definition based on household resources rather than disposable income, but gives a more realistic indication of the extent to which the household sector in aggregate is saving or borrowing.

³ Department for Work & Pensions Expenditure Caseload forecasts (2016).

3.2 – Future trends in household disposable income

So how will household disposable incomes fare in the future? Clearly there are many uncertainties in projecting its growth, but Table 3.2 sets out a plausible main scenario for real growth for each of the key elements of household disposable income growth. In particular we assume that:

- **Total income from wages and salaries** will grow at only a modest real rate of 0.7% in 2017 and around 1% in 2018 due to higher inflation and softer employment growth, before gradually returning to a trend rate of around 2% per annum by 2020.
- **Income of households from gross operating profits** will continue to grow more strongly than wages and salaries for at least the next few years as trends to increased self-employment continue.
- **Income tax and national insurance receipts** will grow broadly in line with wages and salaries.
- **Social security benefits** will fall in real terms in 2017 due to higher inflation and the government's welfare cap for working age benefits. Beyond 2017, the average rate of benefits growth is a little stronger, driven by state pensions, but still relatively modest in real terms as welfare reform programmes continue.

Table 3.2: Main scenario projections of real gross household disposable income growth

	2016e	2017p	2018p	2019p	2020p
Wages and salaries	2.1%	0.7%	1.0%	1.6%	2.0%
Household share of gross operating profits	4.2%	1.8%	2.0%	2.7%	2.4%
Pre-tax earnings	2.7%	1.0%	1.3%	1.9%	2.1%
Income tax paid	2.7%	0.5%	0.9%	1.3%	1.9%
National insurance contribution by workers	1.5%	0.3%	1.2%	1.8%	2.1%
Post-tax earnings	2.9%	1.3%	1.4%	2.1%	2.2%
Social security benefits	1.8%	-0.7%	0.4%	0.4%	1.4%
Post-tax earnings and benefits	2.5%	0.7%	1.1%	1.6%	2.0%
Net property income received (interest, dividends, rent etc.)	-0.1%	-2.6%	0.8%	0.8%	1.6%
Net current transfers	-18.4%	3.1%	2.6%	2.2%	2.0%
Household disposable income	1.6%	0.3%	1.1%	1.5%	1.9%

Sources: PwC main scenario projections

- **Net property income** will shrink by 2.6% in 2017 with only a gradual real recovery in later years as the Bank of England gradually increases its policy rate.

Based on these assumptions, we project that real household disposable income growth will be only around 0.3% in real terms in 2017 (down from an estimated 1.6% in 2016) before converging towards a long-term real trend rate of around 2% per annum in 2020 (and beyond in our illustrative projections to 2030 below). To see how this translates to consumer spending growth we also need to consider how the household savings ratio will change over this period.

3.3– Household saving ratio: trends and projections

The official household savings ratio is defined by the ONS as the difference between available household ‘resources’ (household disposable income plus an adjustment for the change in pension entitlements) and household expenditure, expressed as a proportion of household resources.

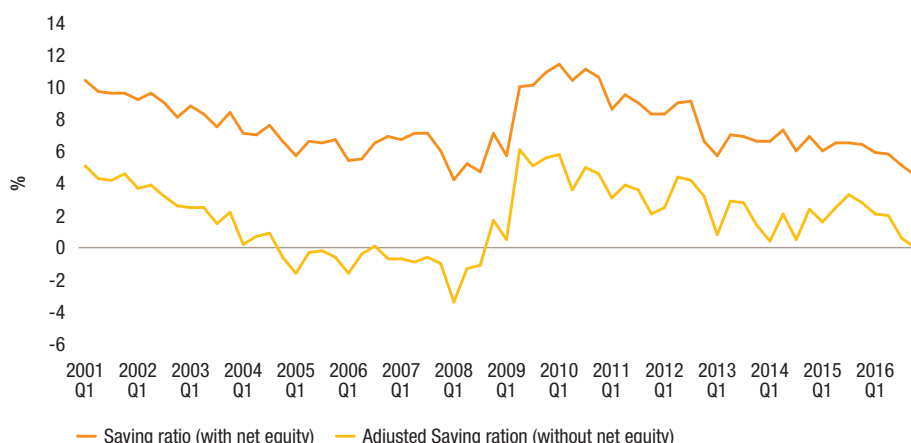
As discussed above, we prefer to focus on an adjusted savings ratio excluding changes in pension entitlements. Figure 3.1 shows how this adjusted ratio compares to the standard ONS measure.

Both saving ratios show broadly similar trends over time but at significantly lower levels for the adjusted savings ratio. We can see that the latter dropped gradually from around 5% in 2001 to around -3% just before the recession began. This took place in a prolonged period of economic stability and easing credit conditions, allowing household debt levels to increase.

Following the shock of the recession, household confidence and borrowing slumped and the adjusted savings ratio jumped sharply to around 6% in 2009. Since the end of the recession in mid-2009, however, the adjusted savings ratio has trended down again as confidence and consumer borrowing revived. The latest post-Brexit adjusted savings ratio for Q3 2016 is close to zero, though still some way above pre-crisis lows.

So how much further, if at all, might the household savings ratio fall in the future, and is a negative adjusted savings ratio sustainable in the longer term?

Figure 3.1 – Historical trends in official and adjusted UK household savings ratios



Source: PwC analysis of ONS data

Table 3.3: Projections of the adjusted household savings ratio in alternative PwC scenarios (% per annum)

	2016e	2017p	2018p	2019p	2020p
Greater fall in saving ratio	1.2%	-1.3%	-2.5%	-3.2%	-3.7%
Main scenario	1.2%	-0.5%	-1.0%	-1.3%	-1.4%
Smaller fall in saving ratio	1.2%	0.4%	0.4%	0.6%	1.0%

Sources: PwC analysis based on ONS data for Q1-Q3 2016

Projecting the adjusted household savings ratio

Projecting forward the savings ratio is subject to considerable uncertainties, reflecting the fact that it reflects the difference between two much large numbers: gross disposable income and consumer spending. To address this issue we used our in-house saving mode⁴ as a guide to develop three plausible scenarios for this ratio, as summarised in Table 3.3. All but one of the scenarios assume some further decline in the adjusted savings ratio between 2017 and 2020 driven by increased household borrowing, but the medium-term average of the ratio could range from around 1% to around -3.7% in the alternative scenarios.

In summary, the adjusted household savings ratio has been on a downward path since 2010 and has continued this trend even after the EU referendum. This helps explain why consumption has remained relatively strong in the aftermath of the referendum vote. We expect some further falls in the adjusted saving ratio at least in 2017, but the extent of any further decline beyond that is subject to considerable uncertainty. On the one hand, households may keep borrowing more on the basis of collateral and confidence effects from continued expected rises in house prices; on the other hand, an eventual gradual rise in UK interest rates in the medium to long run could dampen this confidence and deter borrowing.

⁴ In the November, 2014 UK Economic Outlook we built a model for the adjusted saving ratio with two explanatory variables. For more details on the modelling methodology please see the technical appendix at <http://pdf.pwc.co.uk/ukeyo-consumer-recovery-nov-2014.pdf>

3.4 – Alternative scenarios for consumer spending growth to 2030

We now combine our household disposable income projections from Table 3.2 with our alternative savings ratio scenarios from Table 3.3 to derive scenarios for real consumer spending growth to 2030. Specifically, as set out in Tables 3.4-3.6:

- Our **main scenario** projects real household consumer spending growth will slow down from around 3% in 2016 to around 2% this year followed by a further moderation to 1.7% in 2018. A squeeze on real disposable income growth from higher inflation is the main factor behind the 2017 slowdown, offset in part by some further rise in household borrowing leading to the adjusted savings ratio falling into negative territory this year. Real disposable income growth is projected to be somewhat stronger after this year, but with the savings ratio flattening off this leads to a further moderation in real consumer spending growth in 2018, followed by a gradual recovery to around its 2% long-term trend⁵ from 2020 onwards. This growth profile is broadly similar to the latest OBR forecasts for consumer spending, although they expect an even greater slowdown in 2018 in particular.
- Our **optimistic scenario** is stronger in the short-term due primarily to a sharper further rise in household borrowing in 2017-18 that pushes down the savings ratio to -2.5% by 2018. This type of scenario could be associated with better than expected progress being made in the UK-EU Brexit negotiations together with generally strong global growth conditions. In the long-run, we assume that real disposable income grows faster than the main scenario due to higher UK productivity growth and so supports trend real household expenditure growth of around 2.5% per annum.

- Our **pessimistic scenario** assumes that the savings ratio bottoms out at 0.4% in 2017-18 and then edges up again while real disposable income growth is relatively sluggish. This type of scenario could be associated with less confident UK consumers due to problems in both the global economy and the Brexit negotiations in the medium term, together with disappointing UK productivity growth in the longer term beyond 2020.

While we consider our main scenario to be the most plausible, the other two alternatives are well within the bounds of possibility given current political and economic uncertainties. Consumer-focused businesses would do well to make contingency plans for the downside scenario in particular given the uncertainties associated with the Brexit process over the next few years.

Table 3.4: Main scenario projections of growth in real household expenditure

	2016e	2017p	2018p	2019p	2020p	Average 2021-30p
Real household expenditure	3.1%	2.0%	1.7%	1.8%	2.0%	2.0%
Real household disposable income	1.6%	0.3%	1.1%	1.5%	1.9%	
Adjusted saving ratio	1.2%	-0.5%	-1.0%	-1.3%	-1.4%	

Sources: ONS data for Q1-Q3 2016, PwC estimates and projections for later periods. The figures for 2021-30 are illustrative assumptions for consumer spending only based on alternative views of long-term trend UK GDP growth.

Table 3.5: Optimistic scenario projections of growth in real household expenditure

	2016e	2017p	2018p	2019p	2020p	Average 2021-30p
Real household expenditure	3.1%	3.1%	2.8%	2.8%	2.9%	2.5%
Real household disposable income	1.6%	0.5%	1.6%	2.0%	2.4%	
Adjusted saving ratio	1.2%	-1.3%	-2.5%	-3.2%	-3.7%	

Sources: ONS data for Q1-Q3 2016, PwC estimates and projections for later periods. The figures for 2021-30 are illustrative assumptions for consumer spending only based on alternative views of long-term trend UK GDP growth.

Table 3.6: Downside scenario projections of growth in real household expenditure

	2016e	2017p	2018p	2019p	2020p	Average 2021-30p
Real household expenditure	3.1%	0.9%	0.4%	0.7%	1.1%	1.5%
Real household disposable income	1.6%	0.1%	0.5%	0.9%	1.4%	
Adjusted saving ratio	1.2%	0.4%	0.4%	0.6%	1.0%	

Sources: ONS data for Q1-Q3 2016, PwC estimates and projections for later periods. The figures for 2021-30 are illustrative assumptions for consumer spending only based on alternative views of long-term trend UK GDP growth.

⁵ This is calibrated to match the long-term trend GDP growth rate of around 2% per annum for the UK in the 2020s as estimated in our latest World in 2050 report here: <http://pwc.com/world2050>. We do not try to break down longer term consumer spending growth between household income and savings ratio changes since this is not needed for the analysis and it is hard to anticipate that far ahead how consumer borrowing behaviour in particular will evolve.

3.5 – Projected consumer spending growth by category

Total consumer spending is projected to grow reasonably steadily in our main scenario, but from a business perspective it is important to understand which sectors are likely to see the strongest growth rates. To make these projections, we have updated our in-house longer term consumer spending model, results from which we last published in November 2015.

This econometric model uses factors such as real income levels, relative price levels, demographics and income distribution to project how future consumer spending growth could vary across the main categories of spending. We project these factors forward to 2020 on an annual basis and then also provide some more illustrative longer term projections to 2030. In these projections, as summarised in Figure 3.2 and Table 3.7, we have assumed in particular that:

- total UK household expenditure grows at rates set out in the main scenario in Table 3.4;
- income distribution remains at the latest levels as calculated by the ONS; and
- population shares by age group evolve according to the latest ONS forecasts, which imply a steady rise in the proportion of people above the age of 65.

Figure 3.2 – Historical trends and main scenario projections for household budget shares to 2030

1985 Rank		Spending Share	2016 Rank		Spending Share	2030 Rank		Spending Share
1	Housing & utilities	26.6%	1	Housing & utilities	25.4%	1	Housing & utilities	29.0%
2	Transport	12.6%	2	Transport	13.9%	2	Miscellaneous	15.0%
3	Food	12.2%	3	Miscellaneous	13.3%	3	Transport	12.4%
4	Miscellaneous	9.5%	4	Recreation & Culture	10.1%	4	Recreation & Culture	10.6%
5	Hotels and restaurants	8.8%	5	Hotels and restaurants	9.3%	5	Hotels and restaurants	9.4%
6	Recreation & Culture	7.9%	6	Food	8.2%	6	Food	5.7%
7	Clothing and footwear	6.0%	7	Clothing and footwear	5.8%	7	Furnishing	5.2%
8	Alcohol and tobacco	5.5%	8	Furnishing	4.8%	8	Clothing and footwear	4.3%
9	Furnishing	5.3%	9	Alcohol and tobacco	3.8%	9	Alcohol and tobacco	3.1%
10	Health	3.4%	10	Communication	2.0%	10	Health	1.9%
11	Communication	1.6%	11	Health	1.8%	11	Communication	1.8%
12	Education	0.6%	12	Education	1.6%	12	Education	1.6%

Sources: ONS for historical data, PwC for main scenario projections

Table 3.7 shows that, by 2030, we estimate that households will allocate around 29% of their spending to housing and utilities, compared to around 25% in 2016. This reflects our expectation, based on past research⁶, that supply shortages will keep house prices and rents growing faster than incomes on average. The miscellaneous services category, which includes financial services (including credit cards and insurance) and personal care, is expected to be the second largest expenditure item by 2030 (replacing transport), at almost 14% of total household spending. This makes sense as interest rates are expected to increase gradually in the medium-term, and insurance premiums, including tax, may also tend to rise.

We can also see that the leisure categories (recreation, culture, hotels and restaurants) are also relatively income-elastic and so tend to increase their share of total spending over time as real incomes increase. In contrast, more basic items like food, alcohol and tobacco, and clothing will tend to see their spending shares decline in the long run, continuing the historic trends shown in Figure 3.2.

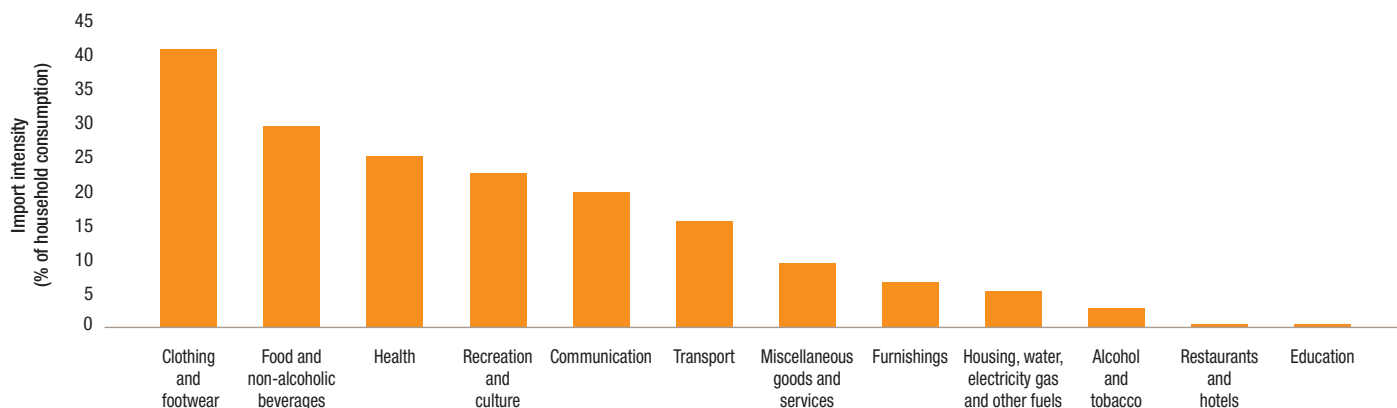
Table 3.7: Household budget share projections to 2030 and implied average real growth rates by household spending category in main scenario

	Spending shares			Implied average real growth rates	
	2016e	2020p	2030p	2016-20p	2021-30p
Alcohol and tobacco	3.8%	3.6%	3.1%	1.3%	0.4%
Clothing and footwear	5.8%	5.3%	4.3%	0.4%	-0.1%
Communications	2.0%	1.9%	1.8%	1.3%	1.6%
Education	1.6%	1.6%	1.6%	1.8%	2.0%
Food	8.2%	7.6%	5.7%	0.8%	-0.7%
Furnishings	4.8%	5.0%	5.2%	2.5%	2.6%
Health	1.8%	1.8%	1.9%	1.9%	2.5%
Housing and utilities	25.4%	26.0%	29.0%	2.4%	3.1%
Miscellaneous services	13.3%	13.9%	15.0%	2.5%	2.8%
Recreation and culture	10.1%	10.3%	10.6%	2.2%	2.4%
Hotels and restaurants	9.3%	9.3%	9.4%	1.8%	2.2%
Transport	13.9%	13.7%	12.4%	1.4%	1.1%
Total spending	100%	100%	100%	2.1%	2.0%

Sources: ONS data for Q1-Q3 2016 and PwC estimates and main scenario projections for later periods.

⁶ See, for example, the article on housing market prospects in the July 2016 edition of UK Economic Outlook here: <https://www.pwc.co.uk/assets/pdf/ukeyo/ukeyo-july-2016-housing-market-outlook.pdf>

Figure 3.3 – Household consumption import intensities



Sources: PwC analysis of ONS data

3.6 – Potential impact of Brexit on key consumer-focused sectors

The future relationship between the UK and the EU is clearly subject to considerable uncertainties and could have many different types of effects on UK businesses (e.g. reconfiguration of supply chains across Europe for some consumer goods). Many of these impacts may be hard to predict in advance given the uncertainties involved and the complexities of the large multinational businesses operating in consumer-related sectors.

However, there are two Brexit-related factors where we can most readily use hard data to try to assess, at least in broad terms, which industry sectors may be more or less exposed to possible adverse effects:

- **Foreign exchange rate:** the fall in the pound has been the most immediate economic effect of the Brexit vote and we can consider how far different sectors rely on imports to evaluate how exposed they may be to this change (exporters may gain, of course, but this is less relevant for those businesses targeting domestic consumer spending, which is our focus in this article).

- **Reliance on EU migrant labour:** looking further ahead to after the UK actually leave the EU, any significant change in the current freedom of movement of workers between the UK and the EU could have important implications for businesses in sectors that are more reliant on EU migrant labour (assuming this is not offset fully by higher net immigration of non-EU workers, which is not current government policy).

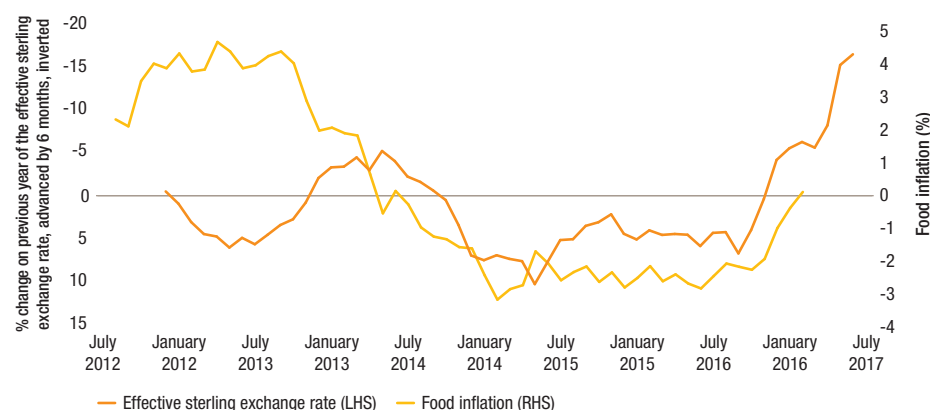
We analyse these two effects in turn below.

Impact of Brexit through the foreign exchange rate channel

The most immediate impact of the referendum vote was felt in the depreciation of sterling by around 10%⁷ against its major trading partners. In general, this means that the “imported” element of the products and services households buy becomes more expensive.

Figure 3.3 shows the reliance of household consumption on imports (so-called “import intensities”) using latest available data from the ONS⁸. This shows that clothing and footwear has the highest import intensity, followed by food and non-alcoholic beverages. These are also two sectors facing many other cost pressures, particularly for traditional high street retailers (e.g. relating to the national living wage, business rates and rents, particularly in London and the South East). Such retailers are also facing increasing competition from online retailers and discounters. Whether the full costs of a weaker pound (once short-term hedges run out) will be passed on to consumers is therefore unclear, but in any case such retailers will suffer from some combination of squeezed margins or, if they try to pass on cost increases, reduces sales volumes.

Figure 3.4 – Relationship between food inflation and the effective sterling exchange rate



Sources: PwC analysis of ONS and Bank of England data

We are already seeing evidence of imported price increases coming through the detailed inflation figures as show in Figure 3.4 for food price inflation, albeit with some lag that could reflect a mixture of forward hedging of exchange rates and competitive constraints on price rises.

For other spending categories, the estimated import intensity is less than 30%. Generally the more non-tradeable sectors e.g. education and housing have lower import intensities as would be expected. The data suggest that the health sector is also quite reliant on imports, however, which probably reflects reliance on imports of medical equipment and pharmaceutical products not produced in the UK.

Possible sectoral impact of Brexit due to future changes in EU migration flows

How reliant are different sectors of the UK economy on EU migrant labour?⁹ To answer this question we looked at ONS data on the breakdown of foreign nationals in the UK workforce. Our analysis in Figure 3.5 shows that:

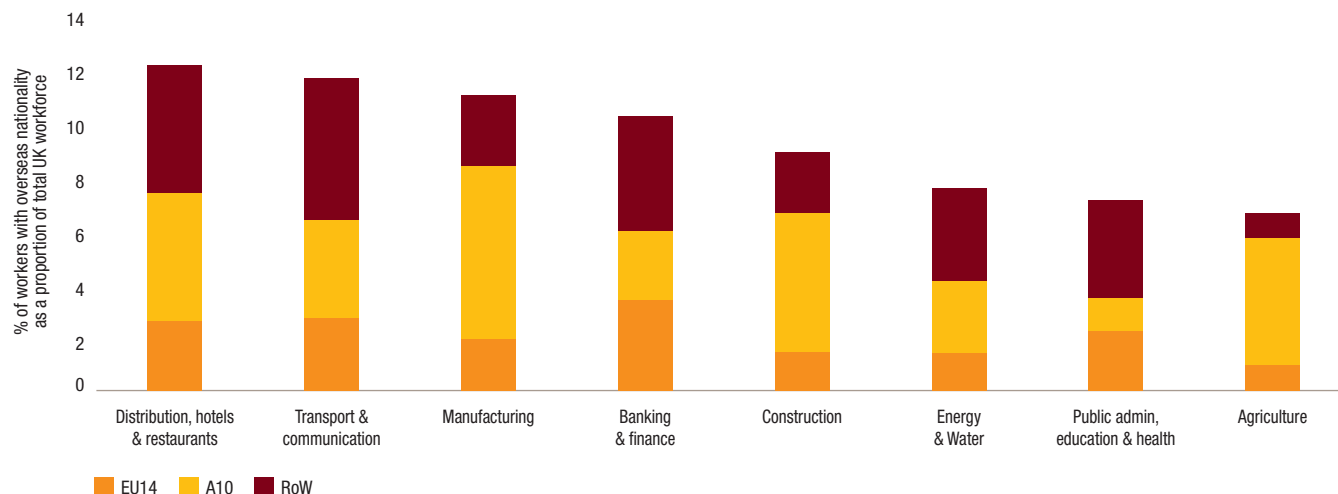
- Around one in ten workers across the UK are foreign nationals with around 6% of jobs held by workers from other EU countries whilst around 4% are held by workers from the rest of the world. The majority of the EU workers in jobs in the UK are from Eastern Europe, though numbers from countries like France, Spain, Greece and Italy have risen due to the high unemployment rates in these countries following the financial crisis.

⁷ We calculated the change in sterling's effective exchange rate since June 2016 based on monthly average data to February 2017 from the Bank of England.

⁸ The ONS produce the “import intensity” of final household consumption for each classification of individual consumption by purpose (COICOP). “Import intensity” refers to the percentage of final household consumption which is directly satisfied by imports. Using sensible assumptions we mapped the different COICOP categories to the household expenditure budget share categories. We then estimated the import intensity for each budget share category by calculating the unweighted, arithmetic average import intensity.

⁹ For more detailed analysis of London in particular, see PwC's recent report with London First here: <http://www.pwc.co.uk/services/legal-services/services/immigration/facing-facts--the-impact-of-migrants-on-london--its-workforce-an.html>

Figure 3.5 – Foreign nationals as a proportion of the UK workforce



Source: ONS

Note: EU14 refers to the first 15 countries admitted to the European Union excluding the UK. A10 economies include all of the economies admitted in May 2004 and January 2007, excluding Cyprus and Malta. Therefore, the rest of the world countries include Cyprus, Malta and Croatia.

- In all but one of the sectors shown in Figure 3.5 (public administration, education and health), EU nationals are a more important source of workers compared to those from the rest of the world. This reflects the fact that it is comparatively easier for EU nationals to move to the UK to work, even though there are many more people in total in the rest of the world than the EU.
- The distribution, hotels and restaurants sector is the most reliant on foreign labour—more than 12% of its workers are from overseas. This sector employs close to 415,000 Europeans and 266,000 rest of the world nationals and so appears the most susceptible to future changes in immigration policy.
- Manufacturing, construction and agriculture are other sectors where EU labour makes up between 6-8% of the workforce.
- Restricting EU migration (without a fully offsetting rise in non-EU migration) could add to labour costs, though it may also give more incentives for the kind of automation of jobs discussed in detail in Section 4 of this report. We already see this trend to more rapid automation in retail and wholesale sectors in other EU countries where labour costs and regulatory burdens tend to be higher than in the UK at present. Shops may increasingly become ‘showrooms’ for products, while sales are mostly made online, so reducing the need for in-store staff.

Our analysis above highlights the importance of foreign labour as an input to businesses and public services in the UK. A key implication of this is that future immigration policy should take into account a variety of sectoral, geographical and other issues and so requires careful handling. Within consumer-focused sectors, the most vulnerable could include retailers, hotels and restaurants, and food producers and processors.

Smaller businesses may also be more exposed than larger companies that can more easily navigate the complexities of whatever new regime emerges for EU (and non-EU) migrant workers after Brexit.

3.7 – Summary and conclusions

Consumer spending has been growing relatively strongly in the past four years on the back of robust employment growth, low inflation (particularly in 2015-16) and continued very low interest rates. In addition, increased consumer confidence, despite recent economic and political uncertainties, has been reflected in a declining household savings ratio driven primarily by increased consumer borrowing.

Looking ahead our analysis suggests that a downward trajectory in the adjusted savings ratio is expected to continue for a year or two before levelling off. But the exact profile of this ratio remains highly uncertain. Meanwhile, real disposable income growth will be squeezed by rising inflation and softening employment growth this year and next.

In our main scenario, we therefore project that real consumer spending growth will ease from around 3% in 2016 to around 2% in 2017 and 1.7% in 2018, before returning to around 2% trend growth in 2020 and beyond. Other scenarios show medium-term real consumer spending growth rates in the range of around 1-3% per annum up to 2020, however, so businesses need to plan for alternative outcomes.

We project that housing and utilities will continue to make up a rising share of total consumer spending, reaching around 29% by 2030 compared to around 25% in 2016. We also expect that financial services and personal care will take a rising share of total consumer spending, while clothing, food, alcohol and tobacco will continue their relative long-term decline.

Brexit adds an additional layer of uncertainty to our consumer spending projections, but we can analyse some potential impacts relating to the weaker pound and possibly future changes in migration policy after the UK leaves the EU. On the first topic, our analysis shows that the clothing and food sectors are potentially most exposed to the fall in sterling due to their high reliance on imports.

Meanwhile, our analysis of sectors which are most reliant on migrant EU labour shows that the retail, hotel and restaurants sectors could prove to be most vulnerable to any significant restrictions on EU workers coming to the UK after Brexit, together with food production and processing and construction. Such sectors need to start making plans now both to help existing EU workers to register as UK residents where possible, and to consider other options like expanding recruitment and training of UK nationals (or non-EU nationals if migration regimes for these are relaxed after Brexit, though this is not current government policy).

Possible reduced availability of relatively low cost labour from other EU countries after Brexit might also increase the incentive for automation in the most affected sectors, as discussed further in the next section of this report.

In summary, while total consumer spending growth is likely to moderate in 2017-18, the aggregate picture does not look too bad. But some consumer-focused sub-sectors are likely to see relatively slower long term spending growth and this will be combined with possible adverse effects from the weaker pound, other cost pressures and potential future migration constraints after Brexit. Businesses in these sectors therefore need to start making appropriate plans now to adjust to alternative post-Brexit scenarios as and when they arise.

4 – Will robots steal our jobs?

The potential impact of automation on the UK and other major economies¹

Key points

- Our analysis suggests that up to 30% of UK jobs could potentially be at high risk of automation by the early 2030s, lower than the US (38%) or Germany (35%), but higher than Japan (21%).
- The risks appear highest in sectors such as transportation and storage (56%), manufacturing (46%) and wholesale and retail (44%), but lower in sectors like health and social work (17%).
- For individual workers, the key differentiating factor is education. For those with just GCSE-level education or lower, the estimated potential risk of automation is as high as 46% in the UK, but this falls to only around 12% for those with undergraduate degrees or higher.
- However, in practice, not all of these jobs may actually be automated for a variety of economic, legal and regulatory reasons.
- Furthermore new automation technologies in areas like AI and robotics will both create some totally new jobs in the digital technology area and, through productivity gains, generate additional wealth and spending that will support additional jobs of existing kinds, primarily in services sectors that are less easy to automate.
- The net impact of automation on total employment is therefore unclear. Average pre-tax incomes should rise due to the productivity gains, but these benefits may not be evenly spread across income groups.
- There is therefore a case for some form of government intervention to ensure that the potential gains from automation are shared more widely across society through policies like increased investment in vocational education and training. Universal basic income schemes may also be considered, though these suffer from potential problems in terms of affordability and adverse effects on the incentives to work and generate wealth.

Introduction

The potential for job losses due to advances in technology is not a new phenomenon. Most famously, the Luddite protest movement of the early 19th century was a backlash by skilled handloom weavers against the mechanisation of the British textile industry that emerged as part of the Industrial Revolution (including the Jacquard loom, which with its punch card system was in some respects a forerunner of the modern computer). But, in the long run, not only were there still many (if, on average, less skilled) jobs in the new textile factories but, more importantly, the productivity gains from mechanisation created huge new wealth. This in turn generated many more jobs across the UK economy in the long run than were initially lost in the traditional handloom weaving industry.

The standard economic view for most of the last two centuries has therefore been that the Luddites were wrong about the long-term benefits of the new technologies, even if they were right about the short-term impact on their personal livelihoods. Anyone putting such arguments against new technologies has generally been dismissed as believing in the ‘Luddite fallacy’.

¹ This article was written by Richard Berriman, a machine learning specialist and senior consultant in PwC's Data Analytics practice, and John Hawksorth, chief economist at PwC. Additional research assistance was provided by Christopher Kelly and Robyn Foyster.

However, over the past few years, fears of technology-driven job losses have re-emerged with advances in ‘smart automation’ – the combination of AI, robotics and other digital technologies that is already producing innovations like driverless cars and trucks, intelligent virtual assistants like Siri, Alexa and Cortana, and Japanese healthcare robots.

While traditional machines, including fixed location industrial robots, replaced our muscles (and those of other animals like horses and oxen), these new smart machines have the potential to replace our minds and to move around freely in the world driven by a combination of advanced sensors, GPS tracking systems and deep learning, if not now then probably within the next decade or two. Will this just have the same effects as past technological leaps – short term disruption more than offset by long term economic gains – or is this something more fundamental in terms of taking humans out of the loop not just in manufacturing and routine service sector jobs, but more broadly across the economy? What exactly will humans have to offer employers if smart machines can perform all or most of their essential tasks better in the future²? In short, has the Luddite fallacy finally come true?

This debate was given added urgency in 2013 when researchers at Oxford University (Frey and Osborne, 2013) estimated that around 47% of total US employment had a “high risk of computerisation” over the next couple of decades – i.e. by the early 2030s.

However, there are also dissenting voices. Notably, Arntz, Gregory and Zierahn (OECD, 2016) last year re-examined the research by Frey and Osborne and, using an extensive new OECD data set, came up with a much lower estimate that only around 10% of jobs were under a “high risk³ of computerisation”. This is based on the reasoning that any predictions of job automation should consider the specific tasks that are involved in each job rather than the occupation as a whole.

In this article we present the findings from our own analysis of this topic, which builds on the research of both Frey and Osborne (hereafter ‘FO’) and Arntz, Gregory and Zierahn (hereafter ‘AGZ’). We then go on to discuss caveats to these results in terms of non-technological constraints on automation and potential offsetting job creation elsewhere in the economy (though this is much harder to quantify).

The discussion is structured as follows:

Section 4.1	What proportion of jobs are potentially at high risk of automation?
Section 4.2	Which industry sectors and types of workers could be at the greatest risk of automation in the UK?
Section 4.3	Why does the potential risk of job automation vary by industry sector?
Section 4.4	How does the UK compare to other major economies?
Section 4.5	What economic, legal and regulatory constraints might reduce automation in practice?
Section 4.6	What offsetting job and income gains might automation generate?
Section 4.7	What implications might these trends have for public policy?
Section 4.8	Summary and conclusions.

Further details of the methodology behind our analysis in Sections 4.1-4.4 are contained in a technical annex at the end of this article, together with references to the other books and studies cited.

² Martin Ford, *The Rise of the Robots* (Oneworld Publications, 2015) is one particularly influential example of an author setting out this argument in detail.

³ In both studies, this is defined as an estimated probability of 70% or more. For comparability, we adopt the same definition of ‘high risk’ in this article.

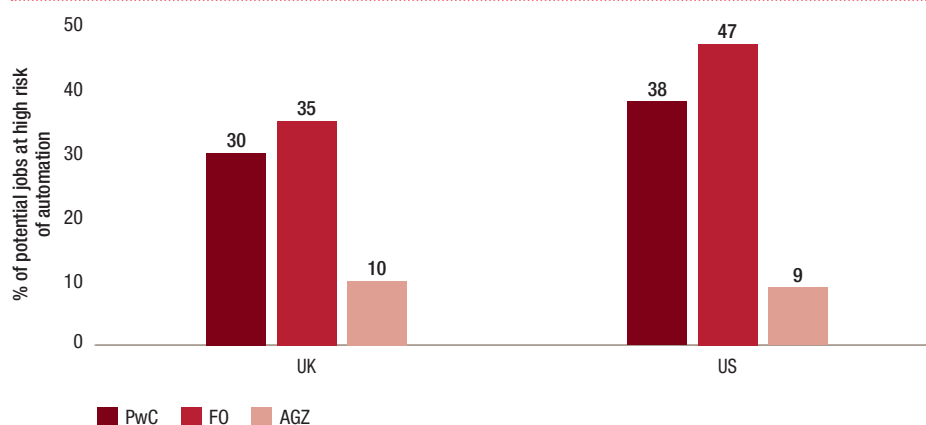
4.1 – What proportion of jobs are potentially at high risk of automation?

In the present article, we start by revisiting the sharply contrasting results of FO and AGZ, who estimate respectively that around 47% and 9% of jobs in the US, and around 35%⁴ and 10% of jobs in the UK are at high risk of automation by, broadly speaking, the early 2030s (see Figure 4.1).

The AGZ study explains the difference as the result of a shift from the occupation-based approach of FO to the task-based approach adopted in their own study. In the original study by FO, a sample of occupations taken from O*NET, an online service developed for the US Department of Labour, were hand-labelled by machine learning experts as strictly automatable or not automatable. Using a standardised set of features of an occupation, FO were then able to use a machine learning algorithm to generate a ‘probability of computerisation’ across US jobs, but crucially they generated only one prediction per occupation. By assuming the same risk in matching occupations, FO were also able to obtain estimates for the UK (other authors have also applied this approach to derive estimates for other countries).

AGZ argue, drawing on earlier research by labour market economists such as David Autor⁵, that it is not whole occupations that will be replaced by computers and algorithms, but only particular tasks that are conducted as part of that occupation.

Figure 4.1 – What proportion of jobs are potentially at high risk of automation?



Sources: PwC analysis; FO; AGZ

Furthermore, the same occupation may be more or less susceptible to automation in different workplaces. Using the same outputs from the FO study, AGZ conducted their analyses on the recently compiled OECD PIAAC database that surveys task structures for individuals across more than 20 OECD countries. This includes much more detailed data on the characteristics of both particular jobs and the individuals doing them than was available to FO.

While recognising the differences in approach, it is still surprising that AGZ obtain results which differ so much from those of FO, bearing in mind that they started from a similar assessment of occupation-level automatability. We therefore conducted our own analyses of the same OECD PIAAC dataset as used in the AGZ study.

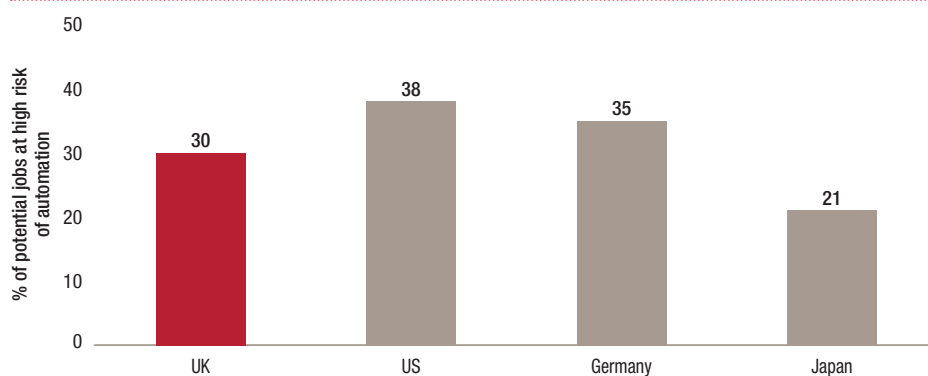
We first replicated the AGZ study findings, but then subsequently enhanced the approach through using additional data and developing our own machine learning algorithm for identifying automation risk⁶. Our findings offer some support for AGZ’s conclusion that taking into account the tasks required to be carried out within each worker’s occupation diminishes the proposed impact of job automation somewhat relative to the FO results. Nevertheless, we conclude that the particular methodology used by AGZ over-exaggerated this mitigating effect significantly.

⁴ Haldane (2015) cites a Bank of England estimate of around this level for the UK based on their version of the FO analysis. This is also in line with other estimates by FO themselves for the UK.

⁵ For example, Autor (2015).

⁶ See Annex for technical details of the methodology used.

Figure 4.2 – Potential jobs at high risk of automation by country



Sources: ONS; PIAAC data; PwC analysis

Specifically, based on our own preferred methodology, **we found that around 30% of jobs in the UK are at potential high risk of automation and around 38% in the US.** These estimates are based on an algorithm linking automatability to the characteristics of the tasks involved in different jobs as well as those of the workers doing them (e.g. the education and training levels required). Our estimates are somewhat lower than the original estimates by FO, but still much closer to those than to the 9-10% estimates of AGZ (see Figure 4.1).

Intuitively, the main reason for this is because the specific approach used by AGZ biased their results towards jobs having only a moderate risk of automation, but we found that this was more an artefact of their methodology than a true representation of the data (see Annex for more technical details of why we reach this conclusion).

Our algorithm could also be applied to other OECD countries in the PIAAC database. For the purpose of the current article, we focus on the results for the UK, US, Germany and Japan⁷. We found that both the US and Germany have an increased potential risk of job automation compared to the UK, whilst Japan has a decreased potential risk of job automation (see Figure 4.2). These reasons for these differences are explored further in Section 4.4 below.

Before exploring our results in more detail, we want to stress one important caveat that applies both to our results and those of FO and AGZ. This is that these are estimates of the potential impact of job automation based on anticipated technological capabilities of AI/robotics by the early 2030s. Not only is the pace of technological advance, and so the timing of these effects uncertain, but more importantly:

- not all of these technologically feasible job automations may occur in practice for the economic, legal and regulatory reasons discussed in Section 4.5 below; and
- even if these potential job losses do materialise, they are likely to be offset by job gains elsewhere as discussed in Section 4.6 below – the net long-term effect on total human employment could be either positive or negative.

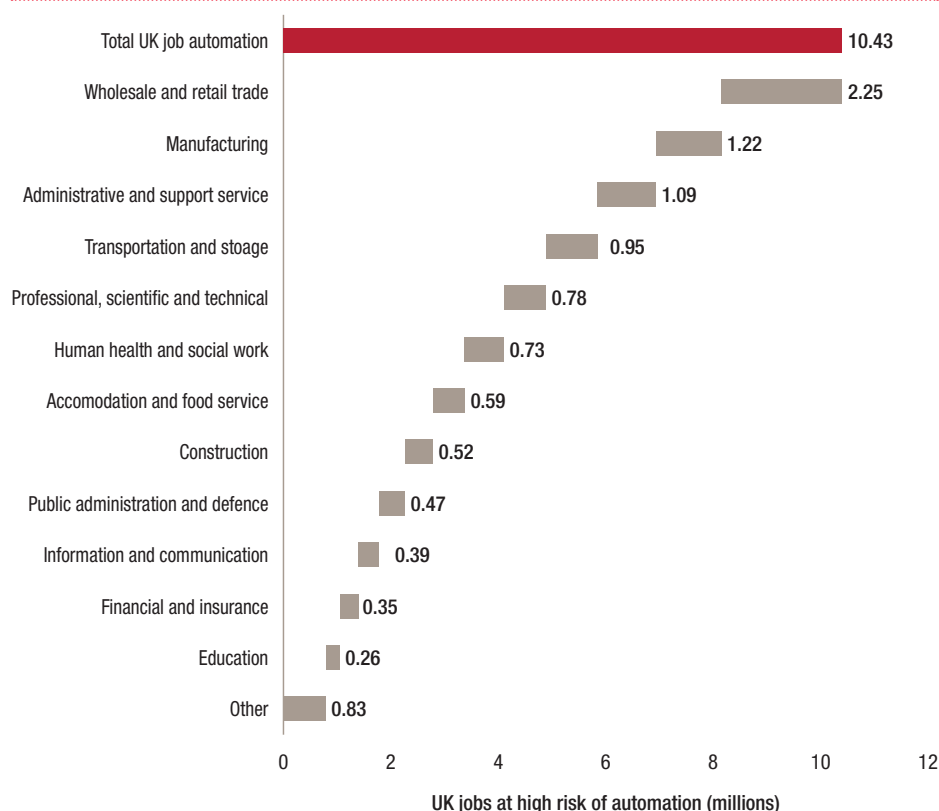
Unfortunately, it is much more difficult to quantify the effects of these caveats, particularly at the industry level, in part because the second one involves new types of jobs being created that do not even exist now. In contrast, we can try to quantify and analyse the number of jobs at potential high risk of automation by country, industry sector and type of worker as discussed below. But, in interpreting these results, we should never lose sight of these two key caveats.

⁷ We also produced estimates for South Korea, but the results – both in aggregate and for particular industry sectors – were very similar to those for Japan, so we do not report them here for reason of space. AGZ also estimated very similar risks for Japan and South Korea, albeit with lower risk levels than our estimates due to the different methodology they applied to essentially the same data set.

4.2 – Which industry sectors and types of workers could be at the greatest potential risk of automation in the UK?

If, for the sake of illustration, we apply our 30% estimate from the previous section to the current number of jobs in the UK⁸, then we might conclude (subject to the caveats noted above) that several million jobs could potentially be at high risk of automation in the UK. Broken down by industry, over half of these potential job losses are in four key industry sectors: wholesale and retail trade, manufacturing, administrative and support services, and transport and storage (see Table 4.1 and Figure 4.3 for details).

Figure 4.3 – Potential jobs at high risk of automation by UK industry sector



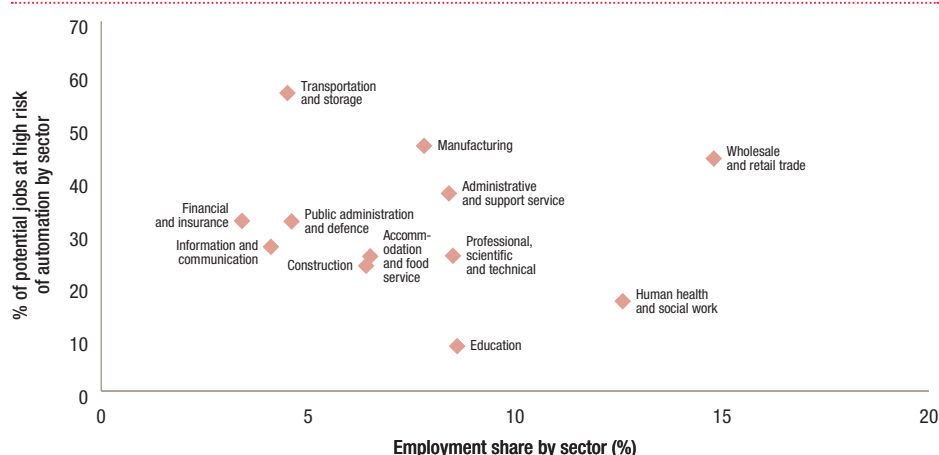
Sources: ONS; PIAAC data; PwC analysis

⁸ In practice, the total number of jobs in the UK is likely to be higher by the early 2030s, which is the approximate date by which we (and FO/AGZ) assume these potential job losses from automation might occur. But, since we do not have detailed job projections that far ahead, we present some illustrative estimates using current data (for 2016) instead.

The magnitude of potential job losses by sector is driven by two main components: the proportion of jobs in a sector we estimate to have potential high risk of automation, and the employment share of that sector (see Figure 4.4 and Table 4.1). The industry sector that we estimate could face the highest potential impact of job automation is the transportation and storage sector, with around 56% of jobs at potential high risk of automation. However, this sector only accounts for around 5% of total UK jobs, so the estimated number of jobs at potential high risk is around 1 million, or around 9% of all potential job losses across the UK.

Instead the highest potential impact on UK jobs is in the wholesale and retail trade sector, with around 2.3 million jobs at potential high risk of automation (22% of all UK jobs estimated to be at high risk) given that this is the largest single sector in terms of numbers of employees. Manufacturing has a similar proportion of current jobs at potential high risk (46%), but lower total numbers at high risk of around 1.2 million due to it being a smaller employer. A further 0.7 million jobs could be at potential high risk of automation in human health and social work, but this is a much lower proportion of all jobs in that sector (around 17%).

Figure 4.4 – Potential impact of job automation by UK industry sector



Sources: ONS; PIAAC data; PwC analysis

Table 4.1 – Employment shares, estimated proportion and total number of employees at potential high risk of automation for all UK industry sectors

Industry	Employment share (%)	Job automation (% at potential high risk)	Jobs at high risk of automation (millions)
Wholesale and retail trade	14.8%	44.0%	2.25
Manufacturing	7.6%	46.4%	1.22
Administrative and support services	8.4%	37.4%	1.09
Transportation and storage	4.9%	56.4%	0.95
Professional, scientific and technical	8.8%	25.6%	0.78
Human health and social work	12.4%	17.0%	0.73
Accommodation and food service	6.7%	25.5%	0.59
Construction	6.4%	23.7%	0.52
Public administration and defence	4.3%	32.1%	0.47
Information and communication	4.1%	27.3%	0.39
Financial and insurance	3.2%	32.2%	0.35
Education	8.7%	8.5%	0.26
Arts and entertainment	2.9%	22.3%	0.22
Other services	2.7%	18.6%	0.17
Real estate	1.7%	28.2%	0.16
Water, sewage and waste management	0.6%	62.6%	0.13
Agriculture, forestry and fishing	1.1%	18.7%	0.07
Electricity and gas supply	0.4%	31.8%	0.05
Mining and quarrying	0.2%	23.1%	0.01
Domestic personnel and self-subsistence	0.3%	8.1%	0.01
Total for all sectors	100%	30%	10.4

Sources: ONS for employment shares (2016); PwC estimates for last two columns using PIAAC data

Which types of UK workers may be most affected by automation?

The potential impact of job automation also varies according to the characteristics of the workers. On average, we find that men and, in particular, those with lower levels of education (GCSE-level and equivalent only or lower) are at greater risk of job automation. This is characteristic of the sectors that are at highest estimated risk. For example, the transportation and storage, manufacturing, and wholesale and retail trade sectors have a relatively high proportion of low education employees (34%, 22%, and 28% respectively). Men also make up the great majority of the workforce in the first two of these sectors (85% and 73%).

We also estimate that private sector employees and particularly those in SMEs are most at risk, which is linked to variations in job and employee characteristics (e.g. education and training levels required).

Table 4.2 – Employment shares, estimated proportion and total number of employees at potential high risk of automation by UK worker characteristics

Worker characteristics	Employment share (%)	Job automation (% at potential high risk)	Jobs at potential high risk of automation (millions)
Gender:			
Female	46%	26%	4.1
Male	54%	35%	6.3
Education:			
Low education (GCSE level or lower)	19%	46%	3.0
Medium education	51%	36%	6.2
High education (graduates)	30%	12%	1.2

Sources: PwC estimates using PIAAC data

Table 4.3 – Estimated proportion of employees at potential high risk of automation by UK employer characteristics

Employer characteristics	Job automation (% at potential high risk)
Public sector	22%
Private sector	34%
Employees:	
<11	30%
11-1000	32%
1000+	24%

Sources: PwC estimates using PIAAC data

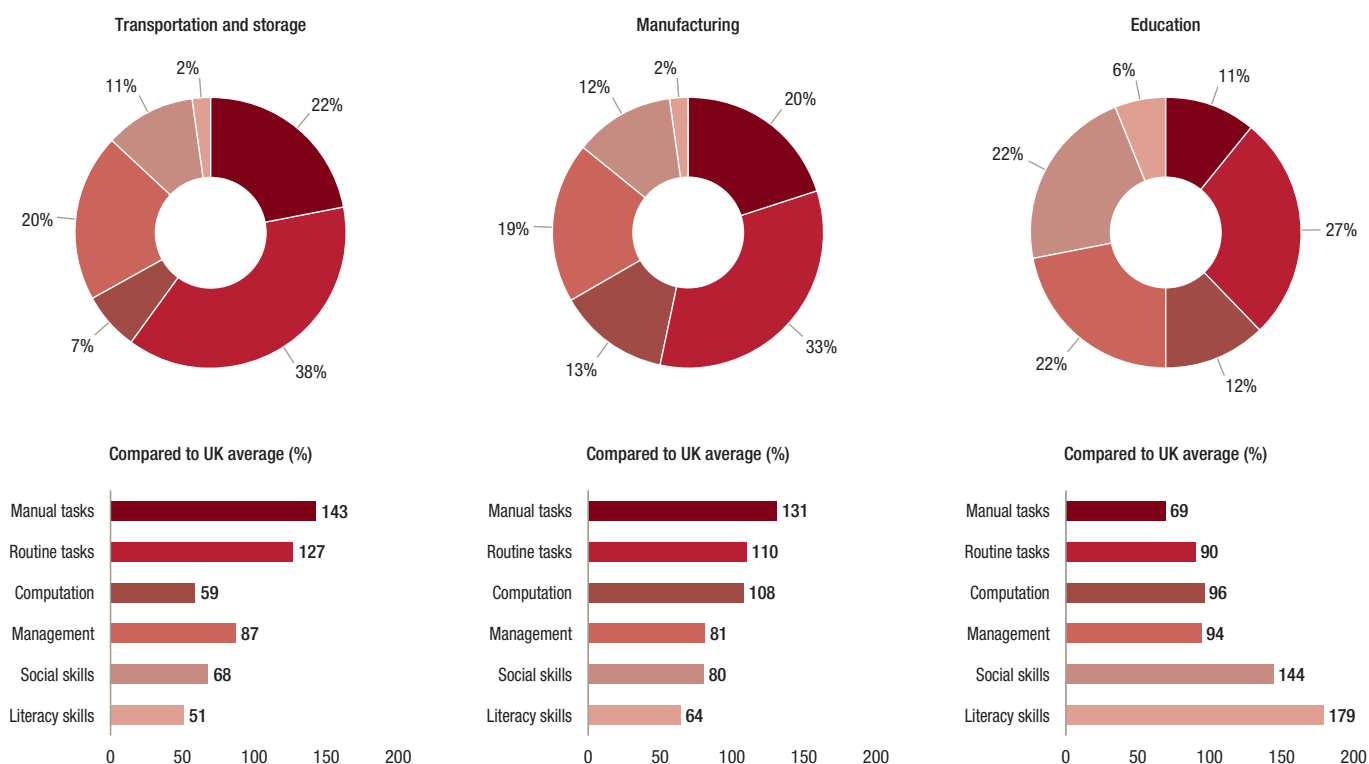
4.3 – Why does potential risk of job automation vary by industry sector?

Task composition

One of the main drivers of a job being at potential high risk of automation is the composition of tasks that are conducted. Workers in high automation risk industries such as transport and manufacturing

spend a much greater proportion of their time engaged in manual tasks that require physical exertion and/or routine tasks such as filling forms or solving simple problems. In contrast, in lower automation risk industries such as education, there is an increased focus on social and literacy skills, as shown in Figure 4.5, which are relatively less automatable⁹.

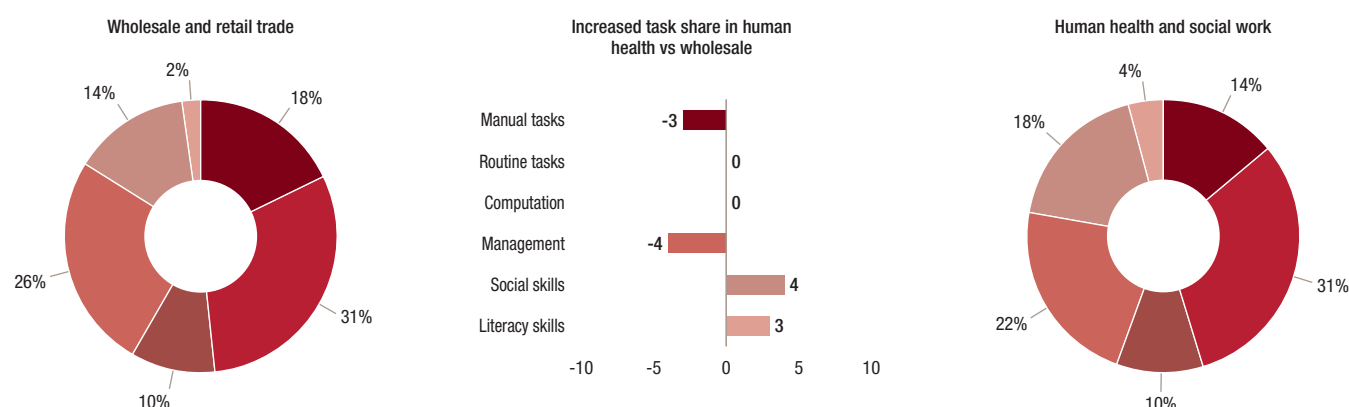
Figure 4.5 – Task composition for UK employees in transportation and storage, manufacturing, and education industry sectors



Sources: PIAAC data; PwC analysis

⁹ Although the considerable growth of e-learning shows that there is scope for automation in education, this may widen access to courses rather than replacing human teachers altogether. For a discussion of how UK universities can prosper in a digital age, see this report: <https://www.pwc.co.uk/assets/pdf/the-2018-digital-university-staying-relevant-in-the-digital-age.pdf>

Figure 4.6 – Task composition comparison for UK employees in wholesale and retail trade, and human health and social work industry sectors



Sources: PIAAC data; PwC analysis

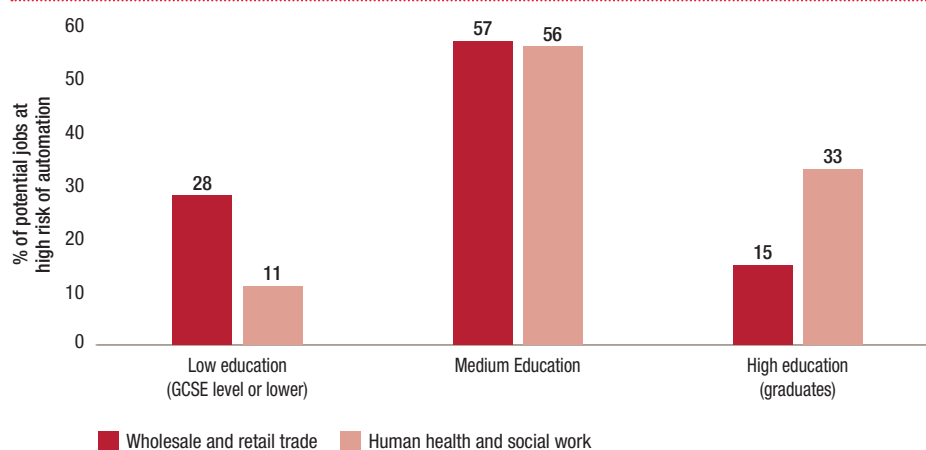
Worker and job characteristics

Task composition of jobs is not, however, the only driver of high automation risk. In the two largest sectors by employment share - wholesale and retail trade and human health and social work - there are broadly comparable task compositions (see Figure 4.6). However, the proportion of jobs at potential high risk of automation is over 2.5x greater in the wholesale and retail trade (44%) than for health and social work (17%).

Instead differences in job requirements are the main factors that cause the risk of automation to differ between these two sectors, mostly significantly as regards education.

On the whole, education requirements are higher in the human health and social work sector, with more than twice the proportion of employees having high education levels (i.e. degree level or higher): 33% compared with 15% in wholesale and retail. Health and social work also has much lower proportions of low education workers (i.e. GCSE level or lower): 11% compared with 28% in wholesale and retail (see Figure 4.7).

Figure 4.7 – Potential impact of job automation by education level for UK employees in wholesale and retail trade, and human health and social work industry sectors



Sources: PIAAC data; PwC analysis

Table 4.4 – Job characteristics for UK employees in wholesale and retail trade, and human health and social work industry sectors

	Wholesale and retail trade	Human health and social work	National average
Required >1 year work experience	32%	48%	47%
High educational job requirements	14%	44%	33%
More training required at work	14%	29%	21%
Moderate/complex computer use at work	51%	61%	68%
Feel challenged at work	11%	15%	12%
Responsible for staff	30%	41%	35%
Co-operate with others > 25% of the time	73%	77%	70%

Sources: PIAAC data; PwC analysis

The difference in education levels is also reflected in the job characteristics for employees in the health and social work sector. There is a much higher proportion of employees that need work experience prior to employment, have higher educational requirements in their current role, and are engaged in more training at work (see Table 4.4).

A more detailed examination of the occupations in both sectors also reveals that a higher proportion of occupations in health and social work are jobs that are far less automatable than in wholesale and retail trade. In particular, sales workers that comprise the majority of employment share in the wholesale and retail trade sector have twice the job automation potential (38%) compared with personal care workers in the human health and social work sector (18%).

The human health and social work sector also has a high proportion of employees (23%) in health professional or health associate professional occupations, which have particularly low automation potential according to our methodology. Advances we have seen in recent years in Japan in healthcare robots might suggest some of these model estimates could prove too low as this technology develops further and spreads to the UK, although some of these may be working with rather than replacing human workers. Similarly surgeons may be able to conduct operations remotely now using digitally-controlled robotics, but (at least for the moment) we are some way from robot surgeons carrying out operations unaided.

4.4 – How does the UK compare to other major economies?

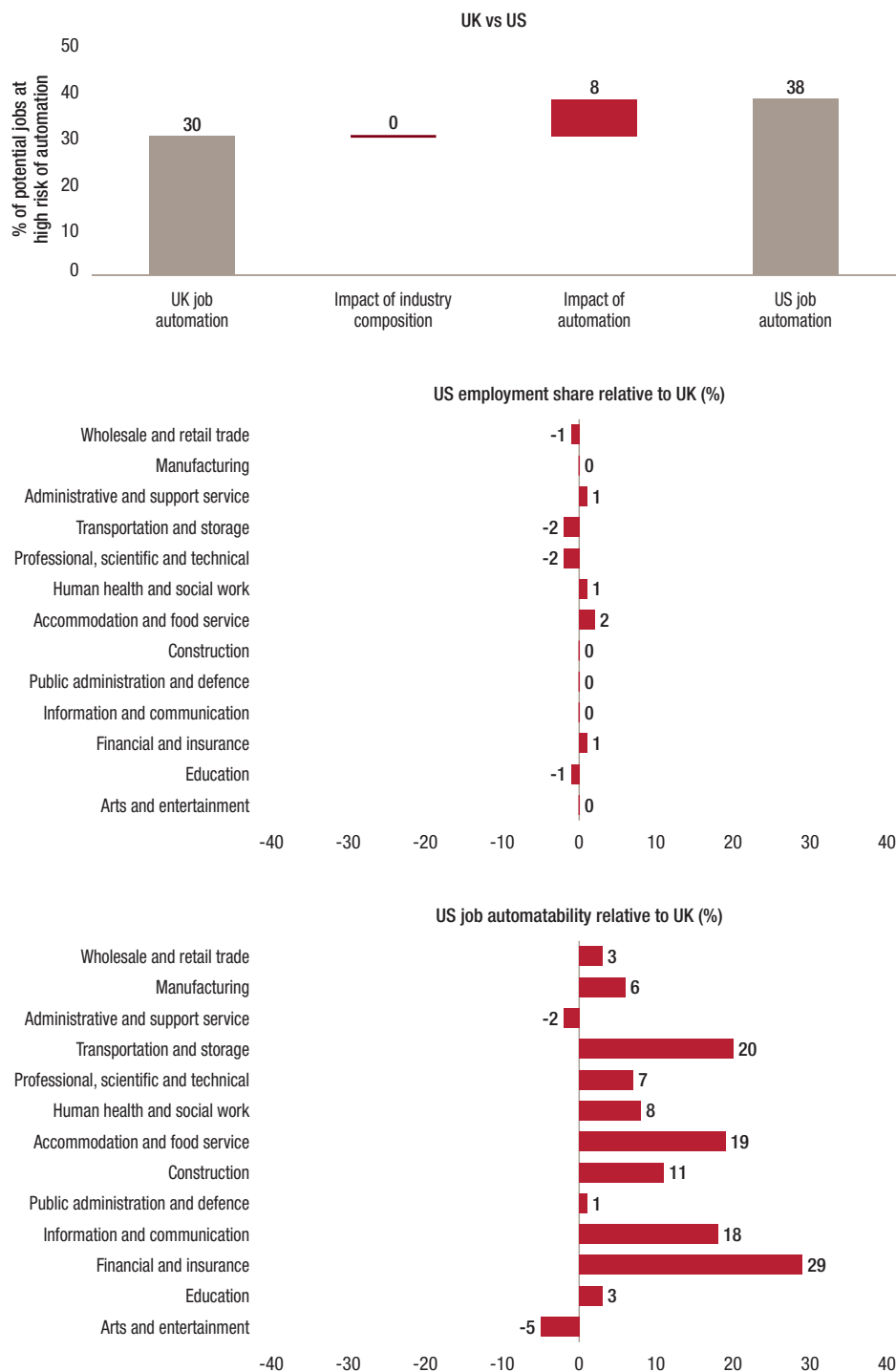
As shown in Figure 4.2 earlier in this article, we estimate that there is a greater potential impact of job automation in the US (38%) and Germany (35%) compared to the UK (30%), but a decreased potential impact in Japan (21%). As with the UK, the potential impact of job automation in other countries is driven by the industry composition of the country (i.e. the employment shares across sectors) and the relative proportion of jobs at high risk of automation in each of those sectors. However, a greater proportion of the variation between countries is explained by differences in the automatability of jobs within sectors.

Why is the estimated risk of job automation higher in the US than the UK?

We find that the larger proportion of jobs at potential high risk of automation in the US is almost exclusively driven by differences in the automatability of jobs for given industry sectors. The US has a similarly service-dominated economy to the UK with relatively little difference in employment shares by industry sector (see middle panel of Figure 4.8). However, several important industry sectors show significantly higher potential job automation risks in the US than in the UK (see bottom panel in Figure 4.8).

The most significant example here is the financial and insurance sector, where automatability is assessed to be much higher in the US (61%) than the UK (32%). Further analysis of the data suggests that the key difference is related to the average education levels of finance professionals being significantly higher in the UK than the US. This may reflect the greater weight in the UK of City of London finance professionals working in international markets, whereas in the US there is more focus on the domestic retail market and many more workers who do not need to have the same educational levels. The jobs of these US retail financial workers are assessed by our methodology as being significantly more routine – and so more automatable – than the average finance sector job in the UK, with its greater weight on international finance and investment banking.

Figure 4.8 – Comparison of potential jobs at high risk of automation between UK and US



Sources: PIAAC data; PwC analysis

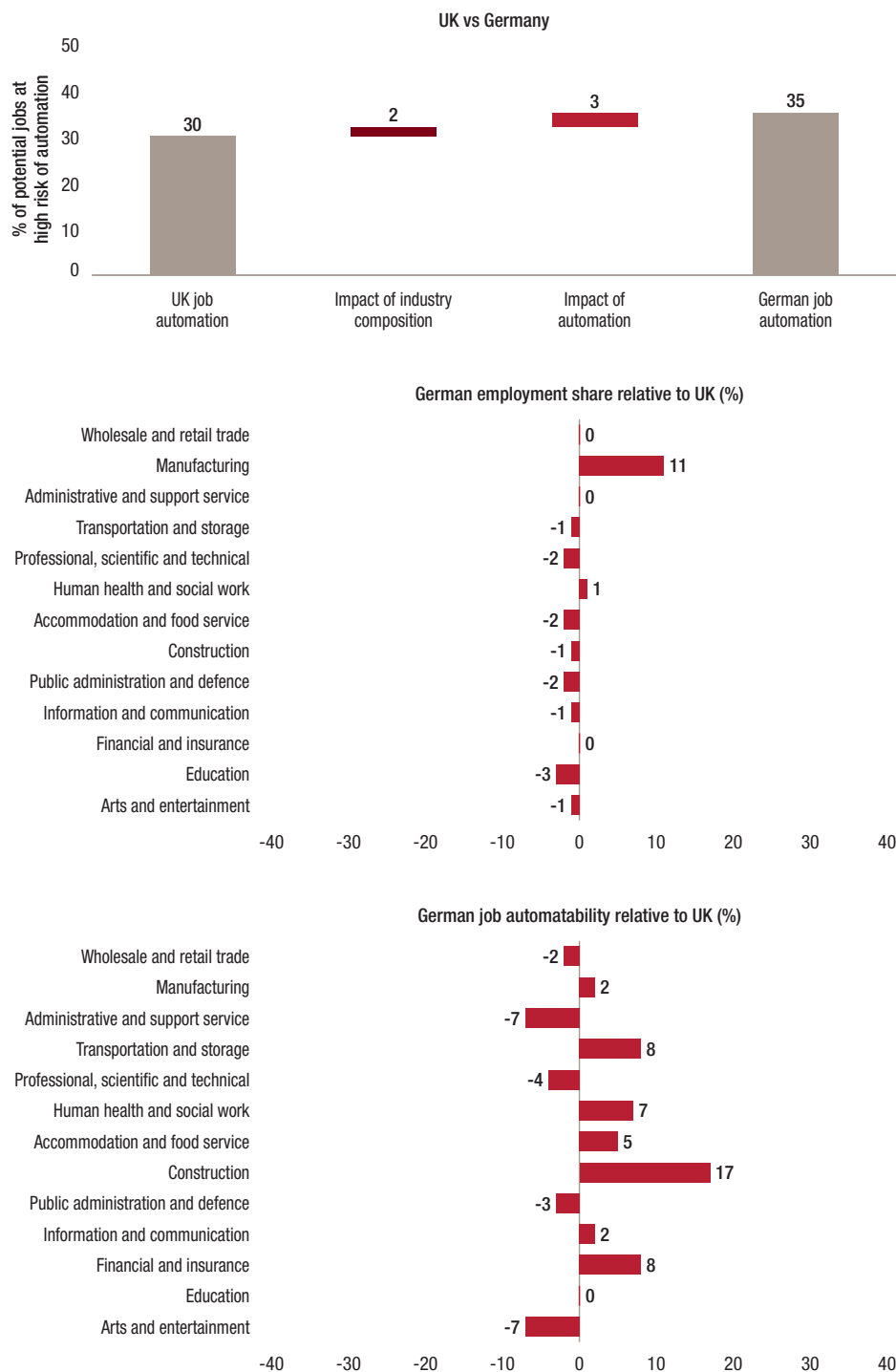
Why is the estimated risk of job automation higher in Germany than the UK?

In Germany, by contrast, the greater proportion of jobs at potential high risk of automation is driven by broadly similar sized impacts from both industry composition and job automatability by sector (see Figure 4.9). In particular, Germany has a higher share of employment in the manufacturing sector than the UK, and manufacturing has a relatively large proportion of jobs at high risk of automation. At the individual sector level, relative automatability levels are varied, but on average higher in Germany.

This is most marked for construction, where the proportion of jobs at high risk of automation is estimated at 41% in Germany but only 24% in the UK. The main difference is that for those working in building and related trades in Germany, 60% of all tasks are either manual or routine, while in the UK these account for only 48% of tasks. Instead there is a greater proportion of time spent on management tasks in the UK, such as planning and consulting others, and those that require social skills such as negotiating.

UK construction workers are therefore classified as being less automatable on average than their German counterparts. Any automation in the construction sector will require major advances in mobile robotics by the early 2030s if our estimates are to prove reliable. It is also unclear here, as in many other sectors, how far these kind of construction robots will work alongside human workers, complementing and enhancing their productivity, rather than replacing them totally. At the very least, there may be a long-lasting intermediate stage in the use of robots in construction and other sectors involving manual tasks outside tightly controlled factory or warehouse conditions.

Figure 4.9 – Comparison of potential jobs at high risk of automation between UK and Germany



Sources: PIAAC data; PwC analysis

Why is the estimated risk of job automation lower in Japan than the UK?

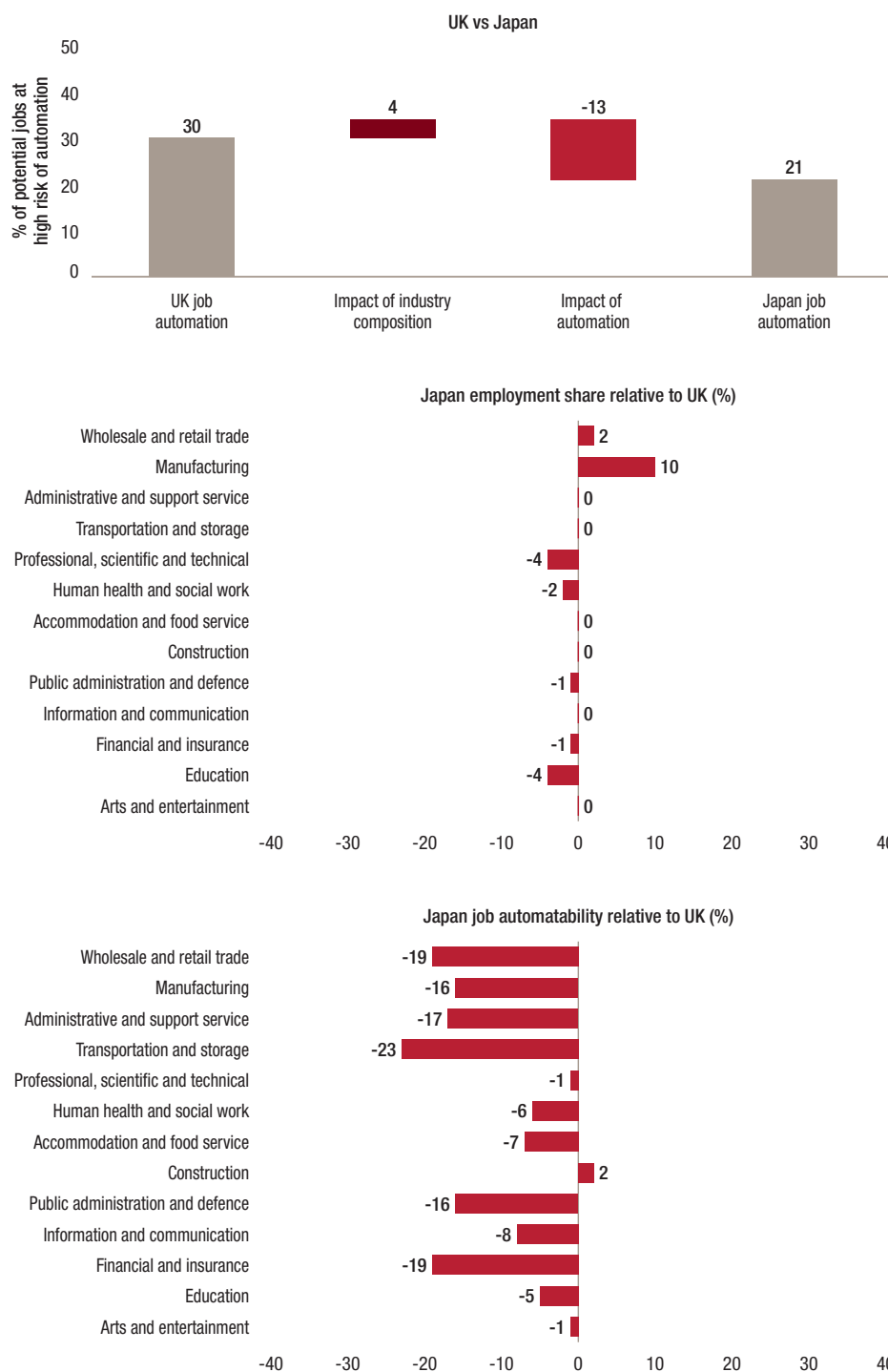
In Japan there is a lower proportion of jobs at high risk of automation than the UK, despite having an industry composition that (like Germany) is more focused on manufacturing, which is one of the most automatable sectors. However, this industry mix effect is more than offset by the lower average automatability of most individual sectors in Japan relative to the UK, as shown in Figure 4.10.

One sector of particular interest because of its high total employment level is the wholesale and retail trade. In Japan, the proportion of jobs at high risk of automation in this sector is estimated at only around 25% as compared to around 44% in the UK

For retail sales workers, we found that the lower proportion of jobs at high risk of automation in Japan is partly due to a lower proportion of time conducting manual tasks compared with management tasks, such as planning or organising. Perhaps linked to this, sales workers in Japan are far more likely to need further training at work (60% compared with 10%) and a significantly higher proportion feel challenged at work (65% compared with 8%).

Whether these projections hold true in the longer run depends on whether there are moves in Japan to change the nature of retailing, making it less labour-intensive on the US or UK model. This might involve customers doing more self-service in Japan than they do now, so reducing the need for skilled sales staff and increasing the need and scope for automation.

Figure 4.10 – Comparison of potential jobs at high risk of automation between UK and Japan



Sources: PIAAC data; PwC analysis

4.5 – What economic, legal and regulatory constraints might restrict automation in practice?

So far the analysis has focused on the technical feasibility of automation based on the characteristics of the jobs (e.g. the tasks required to be done) and their typical workers (e.g. education levels). But, in practice, we recognise that actual future levels of job automation may fall below these levels – or at least take longer to reach them than we might expect on purely technological grounds.

Economic constraints

The first important constraint here is economic – just because it is technically feasible to replace a human worker with a robot, for example, does not mean that it would be economically attractive to do so. This will depend on the relative costs of robots (including energy inputs, maintenance and repairs) relative to human workers, as well as their relative productivity.

In recent years, we have seen rapid total employment growth in the UK, driven in part by relatively subdued (or negative) real wage growth.

Furthermore, a relatively flexible UK labour market that has been open to migration from the EU in particular has made it a comparatively attractive option for companies in many sectors to expand by hiring more people, rather than incurring potentially large up-front costs by investing in new technologies such as AI and mobile robots, which will also seem relatively risky as they may not have been widely tested in practice.

Why take the risk of such investments when there is a low risk, low cost human alternative? Such considerations would apply in sectors like transport, retail and wholesale, hotels and restaurants, and food processing.

Over time, however, we would expect these economic factors to become less significant as the cost of the new digital technologies falls (quite possibly very rapidly if a robotic version of Moore's Law turns out to apply) and they become more widely adopted, leading them to seem less risky and untested by companies that were not early adopters. But it remains highly uncertain in many sectors with low current adoption of robots when the 'tipping point' to much higher adoption will be reached. Organisational inertia and legacy systems may push back the timing of any such shifts towards automation even if they become technically and economically feasible.

Legal and regulatory constraints

Even if economic barriers to adopting automation can eventually be overcome, however, there could also be significant legal and regulatory hurdles to negotiate.

In the case of driverless vehicles¹⁰, for example, the issue of who bears the liability for accidents is a difficult one to resolve – is it the car manufacturer, the manufacturer of the sensors on the car, the provider of the computer software that makes driving decisions, or some combination of these and other suppliers? What about the liability of the human passenger if he or she is expected to take manual control of the vehicle when signalled to do so by the vehicle's computer but failed to do so? And should driverless cars be expected to satisfy higher safety standards than human drivers if that is one of their key selling points?

In the long run, we would expect these kind of legal and regulatory barriers to be overcome in those industries where automation makes economic sense and is technically feasible. But there may often be powerful vested interests arguing against too rapid an advance in automation, so it may well be that realisation of the full potential automation may occur significantly later than the early 2030s timescale we assume in this report (in line with the original FO study).

¹⁰ For a more detailed discussion of these issues, see PwC Strategy&'s 2016 Connected Car report here: <http://www.strategyand.pwc.com/reports/connected-car-2016-study>

4.6 – What offsetting job and income gains might automation generate?

Another key caveat noted earlier in this article is that we have focused so far on estimating the potential job losses from automation. In practice, however, there should also be significant gains from these technologies in terms of:

- completely new types of jobs being created related to these new digital technologies; and
- more significantly in quantitative terms, the wealth from these innovations being recycled into additional spending, so generating demand for extra jobs in less automatable sectors where humans retain a comparative advantage over smart machines.

These offsetting gains are not easy to quantify, but in an earlier PwC study¹¹ with Carl Frey, we estimated that around 6% of all UK jobs in 2013 were of a kind that did not exist at all in 1990. Moreover, in London, this proportion rose to around 10% of all jobs. These were mostly related to new digital technologies such as computing and communications. Similarly, by the 2030s, 5% or more of UK jobs may be in areas related to new robotics/AI of a kind that do not even exist now. It is very difficult to know what these new types of jobs will be in advance, but past experience suggests that there will be some job gains from this source, albeit probably significantly less than the around 30% potential job losses from automation discussed above.

The more significant offsetting factor is that these new automated technologies will boost productivity considerably over time¹² (if not, they will not be adopted on economic grounds). This will generate extra incomes, initially for the owners of the intellectual and financial capital behind the new technologies, but feeding into the wider economy as this income is spent or invested in other areas. This additional demand will generate increased jobs and incomes in sectors that are less automatable, including healthcare and other personal services where robots may not be able to totally replace, as opposed to complement and enhance, workers with the human touch for the foreseeable future¹³.

The historical evidence suggests that this will eventually lead to:

- broadly similar overall rates of employment for human workers, although with different distributions across industry sectors and types of jobs than now;
- higher average real income levels across the country as a whole due to higher overall productivity;
- but quite possibly also a more skewed income distribution with a greater proportion going to those with the skills to thrive in an ever more digital economy – this would put a premium not just on education levels when entering the workforce, but also the ability to adapt over time and reskill throughout a working life.

4.7 – What implications might these trends have for public policy?

The latter point raises important public policy issues. The less controversial one is that the government, working with employers and education providers, should invest more in the types of education and training that will be most useful to people in this increasingly automated world. Exactly how to identify the skills that will be required and develop the training is much more complex of course – for many people, this will involve an increased focus on vocational training¹⁴ that is constantly updated to stay one step ahead of the robots. It also requires better matching of workers to the new opportunities that will arise in an increasingly digital economy. But the principle of investing more in education, skills and retraining seems widely accepted.

Central and local government bodies also need to support digital sectors that can generate new jobs, for example through place-based strategies centred around university research centres, science parks and other enablers of business growth. This place-based approach is one of the key themes in the government's new industrial strategy and its wider devolution agenda. It also involves extending the latest digital infrastructure beyond the major urban centres to facilitate small digital start-ups in other parts of the country.

11 C. Frey and J. Hawksworth (PwC, 2015): <http://www.pwc.co.uk/assets/pdf/ukeyo-regional-march-2015.pdf>

12 See, for example, this 2015 PwC report on the potential productivity benefits of service robots:

<http://www.pwc.com/us/en/technology-forecast/2015/robotics/features/service-robots-big-productivity-platform.html>

13 Of course, eventually, we may reach the science fiction scenario where robots become indistinguishable in all ways from humans. At present, that seems likely to be much further off than the early 2030s time horizon we are focusing on in this study, though this could always change given recent rapid advances in AI and robotics.

14 An area where the UK lags well behind countries like Germany as highlighted in our 2016 Young Workers Index report here: <http://www.pwc.co.uk/services/economics-policy/insights/young-workers-index.html>

More controversial is whether governments should intervene more directly to redistribute income¹⁵.

In particular, the idea of a universal basic income (UBI) has gained traction in Silicon Valley and elsewhere as a potential way to maintain the incomes of those who lose out from automation and (to be hard headed about it) whose consumption is important to keep the economy going. The problem with UBI schemes, however, is that they involve paying a lot of public money to many people who do not need it, as well as those that do. As such the danger is that such schemes are either unaffordable or destroy incentives to work and generate wealth, or they need to be set too low to provide an effective safety net.

Nonetheless, we are now seeing practical trials of UBI schemes in a number of countries around the world including Finland, the Netherlands, some US and Canadian states, India and Brazil. The details of these schemes vary considerably, and it is beyond the scope of this article to review them in depth, but it seems likely that more pilot schemes of this kind will emerge around the world and that they will come on to the policy agenda in the UK as well. For the moment, the need to reduce the UK budget deficit may be a significant barrier to any such scheme on a national level, as well as concerns about the social acceptability of giving people ‘money for nothing’. But the wider question of how to deal with possible widening income gaps arising from increased automation seems unlikely to go away.

4.8 – Summary and conclusions

Our analysis suggests that around 30% of UK jobs could potentially be at high risk of automation by the early 2030s, lower than the US (38%) or Germany (35%), but higher than Japan (21%).

The risks appear highest in sectors such as transportation and storage (56%), manufacturing (46%) and wholesale and retail (44%), but lower in sectors like health and social work (17%).

For individual workers, the key differentiating factor is education. For those with just GCSE-level education or lower, the estimated potential risk of automation is as high as 46% in the UK, but this falls to only around 12% for those with undergraduate degrees or higher.

However, in practice, not all of these jobs may actually be automated for a variety of economic, legal and regulatory reasons.

Furthermore new technologies in areas like AI and robotics will both create some totally new jobs in the digital technology area and, through productivity gains, generate additional wealth and spending that will support additional jobs of existing kinds, primarily in services sectors that are less easy to automate.

The net impact of automation on total employment is therefore unclear. Average pre-tax incomes should rise due to the productivity gains, but these benefits will probably not be evenly spread across income groups. The pay premium for higher education and non-automatable skills will also probably rise ever higher.

There is therefore a case for some form of government intervention to ensure that the potential gains from automation are shared more widely across society through policies in areas like education, vocational training and job matching. Some form of universal basic income scheme might also be considered though this does face problems relating to affordability and potential adverse incentive effects that would need to be addressed.

¹⁵ Another idea here is the recent suggestion of Bill Gates to tax robots where these displace human labour. However, it is not clear that such a specific tax on investment in robots would be economically efficient. Other labour-saving technologies do not face such specific taxes, so why single robots out for such treatment and potentially lose productivity gains from such innovation and investment?

Annex

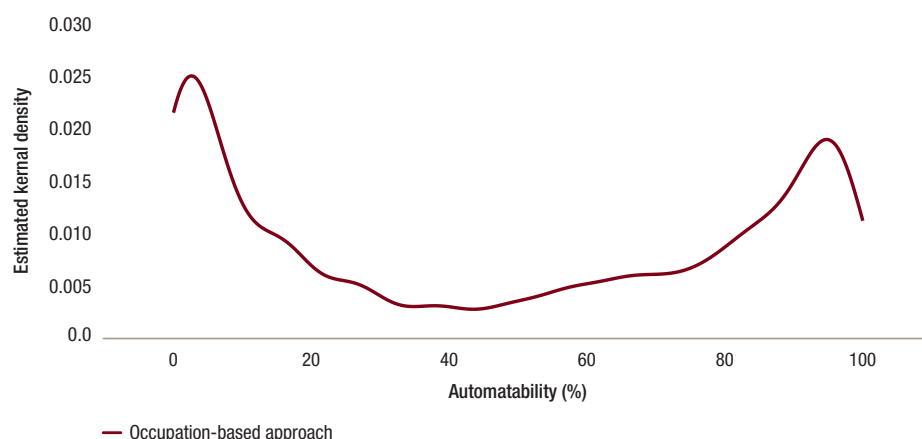
Technical details of our methodology

In the present study, we first recreated the dataset from Arntz, Gregory and Ziehn (AGZ, 2016). This comprised US data from the Programme for the International Assessment of Adult Competencies (PIAAC) database, merged with automatability data from FO. However, these sources use different occupation classifications: the 702 O*NET occupations from FO were classified using the Standard Occupational Classification (SOC) 2010 codes, whilst the PIAAC database contained occupations classified using the first 2-digits from International Standard Classification of Occupations (ISCO-08) codes.

To map the FO data with SOC codes to the PIAAC data with ISCO-08 codes we used cross-walks from the US Census Bureau. This results in an expanded dataset with many-to-one relationships from the FO data to PIAAC data. As per AGZ, each duplicated case in the expanded dataset was assigned a weight that sums to unity for each individual.

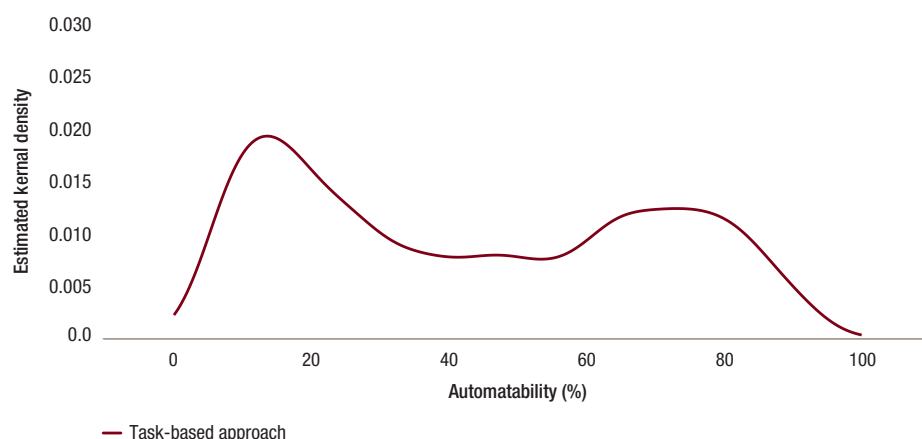
We then replicated the Expectation-Maximisation (EM) algorithm by AGZ that iteratively: predicts the ‘probability of computerisation’ scores from FO using a fractional logit model, and then re-calculates the first weights proportionally to the prediction residuals (see AGZ for further details). Through this procedure we replicated the distribution of automatability in the US from AGZ for the occupation-based and task-based approaches (see Figures 4.A1 and 4.A2 respectively).

Figure 4.A1 – Replication of the AGZ occupation-based approach



Sources: PIAAC data; FO automatability data; PwC analysis

Figure 4.A2 – Replication of the AGZ task-based approach



Sources: PIAAC data; FO automatability data; PwC analysis

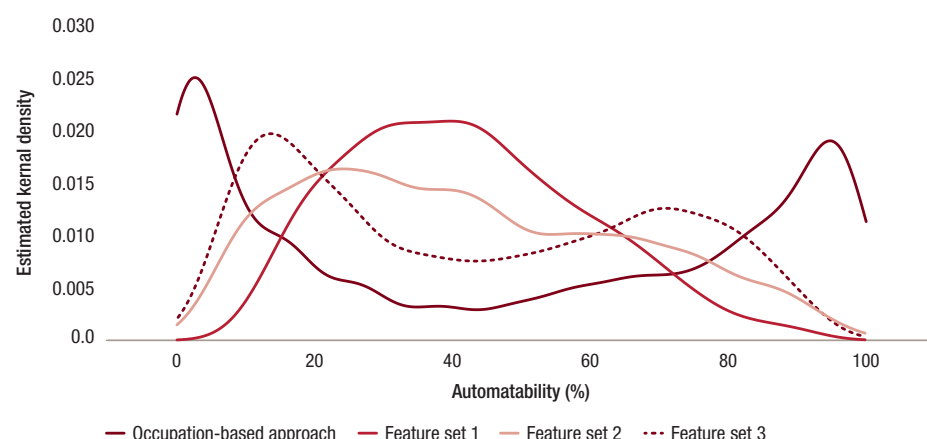
However, we consider that the low proportion of jobs with ‘high automatability’ (i.e. >70% risk of automation) in AGZ’s task-based approach is an artefact of their predictive model. To illustrate this we re-simulated the EM algorithm from AGZ using different sets of predictive features (see Figure 4.A3).

As the feature set increases from ‘feature set 1’ to ‘feature set 3’ and performance metrics of the classifier improve, the task-based approach curve shifts from the centre to more closely match the occupation-based approach distribution. Accordingly, the proportion of jobs estimated to have high automatability also increases. In other words, the more predictive the model the higher the estimation of high automatability jobs.

To improve the methodology we split the analytics into two parts: an initial application of the EM algorithm to only re-weight the cross-walked dataset, and a second phase of building an enhanced classifier algorithm. A re-simulation of the task-based approach with the EM method for weights only is shown in Figure 4.A4.

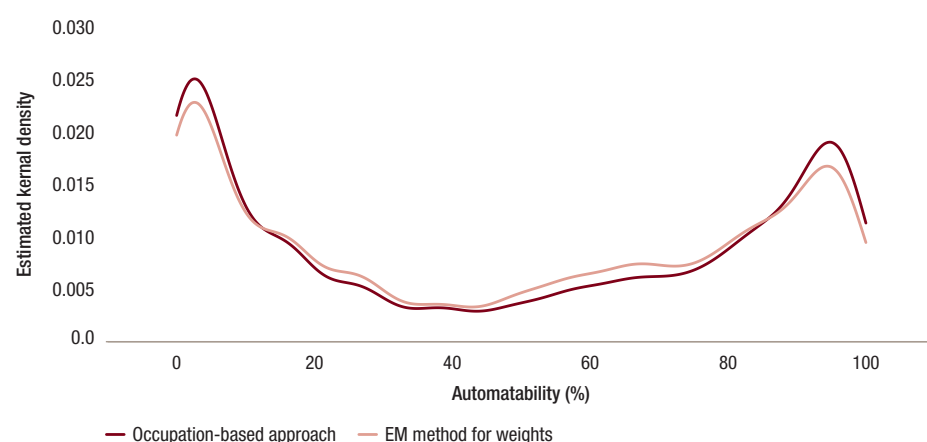
The algorithm developed using the US extended dataset was then applied to the original US dataset and recalibrated accordingly. This enhanced and recalibrated model could then be applied to each of the other OECD countries. The present report contains results for the US, UK, Germany and Japan.

Figure 4.A3 – Re-simulated task-based approach



Sources: PIAAC data; FO automatability data; PwC analysis

Figure 4.A4 – EM method applied to cross-walk weights only



Sources: PIAAC data; FO automatability data; PwC analysis

References

- Arntz, M., T. Gregory and U. Zierahn (2016), ‘The risk of automation for jobs in OECD countries: a comparative analysis’, OECD Social, Employment and Migration Working Papers No 189.
- Autor, D. H. (2015), ‘Why are there still so many jobs? The history and future of workplace automation’, *Journal of Economic Perspectives*, 29(3), pp.3-30.
- Ford, M. (2015), *The Rise of the Robots*, Oneworld Publications.
- Frey, C.B. and M.A. Osborne (2013), *The Future of Employment: How Susceptible are Jobs to Computerization?*, University of Oxford.
- Frey, C.B. and J. Hawksworth (2015), ‘New job creation in the UK: which regions will gain the most from the digital revolution?’, *PwC UK Economic Outlook*, March 2015. Available from: <http://www.pwc.co.uk/assets/pdf/ukeyo-regional-march-2015.pdf>
- Haldane, A. (2015) ‘Labour’s share’, speech to the TUC, London, 15 November 2015. Available from: <http://www.bankofengland.co.uk/publications/Pages/speeches/2015/864.aspx>
- PwC Strategy & Connected Car Report (2016). Available from: <http://www.strategyand.pwc.com/reports/connected-car-2016-study>
- PwC Technology Forecast (2015), ‘Service robots: the next big productivity platform’. Available from: <http://www.pwc.com/us/en/technology-forecast/2015/robotics/features/service-robots-big-productivity-platform.html>
- PwC (2016), *The 2018 digital university: staying relevant in a digital age*. Available here: <https://www.pwc.co.uk/assets/pdf/the-2018-digital-university-staying-relevant-in-the-digital-age.pdf>
- PwC (2016), *Young Workers Index: Empowering a new generation*. Available here: <http://www.pwc.co.uk/services/economics-policy/insights/young-workers-index.html>

Appendix A

Outlook for the global economy

Table A.1 presents our latest main scenario projections for a selection of economies across the world.

World economic growth strengthened through 2016 and this is expected to continue, increasing the global weighted average real growth rate to 2.9% in 2017 and 3% in 2018 (using GDP at market exchange rates as weights). This growth is expected to be driven by the large emerging economies with continued strong growth of around 7-8% in India and around 6-6.5% in China projected for 2017 and 2018. The outlook for emerging markets has also improved as a result of improving economic conditions in Russia and Brazil, which are now moving out of recession.

Steady but moderate growth of around 1.6% is projected for the Eurozone in 2017-18 although this is subject to potential political volatility due to upcoming elections in France and Germany. Relative to the rest of the G7, quite strong growth is projected for the US economy in 2017-18 as fiscal stimulus strengthens an already recovering economy. But this could be offset by further gradual rises in US interest rates to keep inflation under control.

These projections are updated monthly in our Global Economy Watch publication, which can be found at www.pwc.com/gew

Table A.1: Global economic growth and inflation prospects

	Share of world GDP	Real GDP growth (%)		Inflation (%)	
	2016 at MERs	2017	2018	2017	2018
US	24.5%	2.2	2.4	2.3	2.5
China	15.2%	6.5	6.1	1.8	2.5
Japan	5.6%	0.5	0.7	1.3	1.5
UK	3.9%	1.6	1.4	2.3	2.8
France	3.3%	1.4	1.6	1.2	1.1
Germany	4.6%	1.6	1.5	1.8	1.9
Greece	0.3%	1.6	2.0	0.5	0.7
Ireland	0.4%	3.2	3.0	0.8	1.3
Italy	2.5%	1.0	1.1	1.1	0.8
Netherlands	1.0%	1.6	1.8	1.5	1.1
Portugal	0.3%	1.1	1.2	1.0	1.0
Spain	1.6%	2.3	1.9	1.3	1.1
Poland	0.6%	3.4	3.2	1.2	1.7
Russia	1.8%	1.0	1.1	5.6	4.8
Turkey	1.0%	2.9	3.2	8.1	8.4
Australia	1.7%	2.7	2.9	2.5	2.4
India	2.8%	7.3	7.7	5.0	5.3
Indonesia	1.2%	5.1	5.5	4.5	4.4
South Korea	1.9%	2.6	2.8	1.6	2.8
Argentina	0.9%	1.9	2.4	25	n/a
Brazil	2.4%	0.4	1.5	5.0	4.5
Canada	2.1%	1.9	2.1	1.9	2.0
Mexico	1.6%	1.8	2.1	3.4	3.0
South Africa	0.4%	1.0	1.7	6.0	5.7
Nigeria	0.7%	0.9	2.4	14.2	12.0
Saudi Arabia	0.9%	1.2	2.0	3.2	3.0
World (PPP)		3.4	3.5	3.1	3.0
World (Market Exchange Rates)	100%	2.9	3.0	2.7	2.6
Eurozone	15.8%	1.6	1.6	1.3	1.3

Source: PwC main scenario for 2017 and 2018; IMF for GDP shares in 2016 at market exchange rates (MERs).

Appendix B

UK economic trends: 1979 – 2016

Annual averages	GDP growth	Household expenditure growth	Manufacturing output growth*	Inflation (CPI**)	3 month interest rate (% annual average)	Current account balance (% of GDP)	PSNB*** (% of GDP)
1979	3.7	4.8			13.7	-0.6	4.3
1980	-2.0	0.1			16.6	0.5	3.9
1981	-0.8	0.3			13.9	1.5	3.1
1982	2.0	1.2			12.2	0.6	2.3
1983	4.2	4.4			10.1	0.2	3.0
1984	2.3	2.5			10.0	-0.5	3.3
1985	4.2	5.1			12.2	-0.3	2.6
1986	3.2	6.1			10.9	-1	2.0
1987	5.4	5.1			9.7	-1.6	1.3
1988	5.8	7.4			10.4	-3.6	-0.6
1989	2.6	3.9		5.2	13.9	-4.1	-0.6
1990	0.7	1.0		7.0	14.8	-3.1	0.6
1991	-1.1	-0.6		7.5	11.5	-1.3	2.6
1992	0.4	0.9		4.3	9.6	-1.5	5.6
1993	2.5	2.8		2.5	5.9	-1.3	6.8
1994	3.9	3.2		2.0	5.5	-0.5	5.8
1995	2.5	2.1		2.6	6.7	-0.7	4.7
1996	2.5	3.9		2.5	6.0	-0.6	3.3
1997	3.1	4.5		1.8	6.8	-0.2	1.6
1998	3.2	3.9	0.4	1.6	7.3	-0.4	-0.1
1999	3.3	4.9	0.6	1.3	5.4	-2.4	-1.1
2000	3.7	4.9	2.2	0.8	6.1	-2.1	-1.8
2001	2.7	3.5	-1.5	1.2	5.0	-1.9	-0.6
2002	2.4	3.7	-2.2	1.3	4.0	-2	1.6
2003	3.5	3.8	-0.6	1.4	3.7	-1.7	2.6
2004	2.5	3.3	1.8	1.3	4.6	-1.8	2.7
2005	3.0	3.0	0.0	2.1	4.7	-1.2	2.9
2006	2.5	1.8	2.2	2.3	4.8	-2.2	2.6
2007	2.6	3.0	0.6	2.3	6.0	-2.4	2.4
2008	-0.6	-0.8	-2.8	3.6	5.5	-3.5	5.2
2009	-4.3	-3.5	-9.4	2.2	1.2	-3	10.1
2010	1.9	0.7	4.6	3.3	0.7	-2.7	9.1
2011	1.5	-0.7	2.2	4.5	0.9	-1.8	7.1
2012	1.3	1.9	-1.5	2.8	0.8	-3.7	7.7
2013	1.9	1.6	-1.0	2.6	0.5	-4.4	5.9
2014	3.1	2.1	2.9	1.5	0.5	-4.7	5.6
2015	2.2	2.5	-0.2	0.0	0.6	-4.3	4.2
2016	1.8	3.1	0.7	0.7	0.5	-4.9	3.0
Average over economic cycles****							
1979 - 1989	2.8	3.7			12.2	-0.8	2.2
1989 - 2000	2.3	3.0		3.3	8.3	-1.5	2.3
2000 - 2014	1.8	1.9	-0.2	2.2	3.3	-2.6	4.2

* After the revisions to the national accounts data, pre-1998 data is not currently available ** Pre-1997 data estimated *** Public Sector Net Borrowing (calendar years excluding public sector banks)

**** Peak-to-peak for GDP relative to trend

Sources: ONS, Bank of England

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