



BANK OF ENGLAND

Speech

Investment and uncertainty: the value of waiting for news

Speech given by

Ben Broadbent, Deputy Governor Monetary Policy

Imperial College Business School, London

20 May 2019

I've received helpful comments from colleagues at the Bank of England. I'd particularly like to thank Mette Nielsen for her help in preparing the speech. The views expressed are my own and do not necessarily reflect those of the Bank of England or other members of the Financial Policy Committee or the Monetary Policy Committee.

Good evening!

Today I want to talk about “Brexit uncertainty” and investment. This is hardly a new topic. Indeed I put the words in quotes because the phrase has become so commonplace. At least in the context of the economy one rarely hears one without the other attached to it.

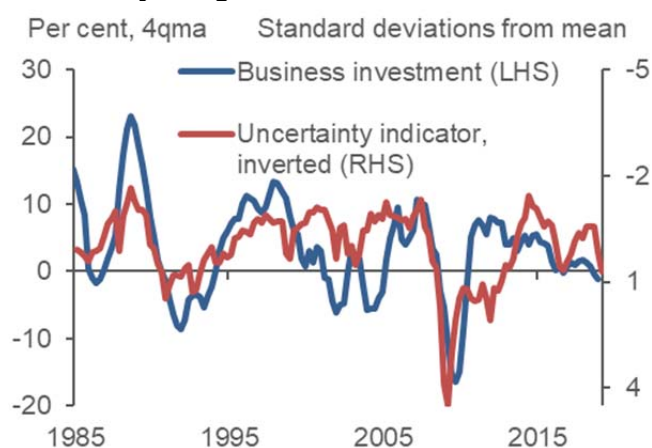
There are good reasons for that, of course.

We know from general experience – from the empirical evidence in the UK and elsewhere (Chart 1) – that greater uncertainty tends to reduce investment spending.

It’s also clear, from direct conversation and from more formal surveys, that many businesses are apprehensive about Brexit. Over half of the respondents to the Bank’s Decision Maker Panel, a survey of over 7,000 firms, now count Brexit as one of their three most important sources of risk (Chart 2).¹ According to a survey by the Bank’s Agents the outcome they think will have the most negative economic impact is a no-deal exit with no agreed transition period. The blue bars in Chart 3 plot what firms expect to happen to their own output and employment in that case.

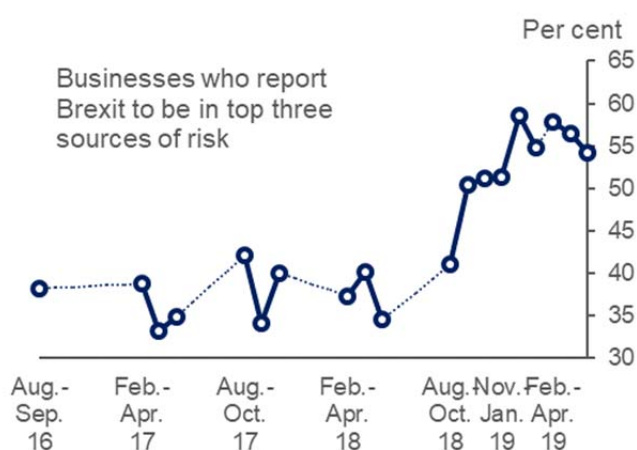
And, over time, the impact of that nervousness has started to come through in the official data. It didn’t to begin with, in the first year or so after the referendum. The series is quite volatile, and prone to revision, so one should be careful not to over-interpret shorter-term movements. But on current estimates, business investment was 3% higher at the end of 2017 than in mid-2016.

Chart 1: Businesses invest less when uncertainty is high



Sources: ONS, Bloomberg Finance L.P., CBI, Consensus Economics, Dow Jones Factiva, Eikon from Refinitiv, GfK (research on behalf of the European Commission) and Bank calculations.
Growth in business investment is one quarter ahead.

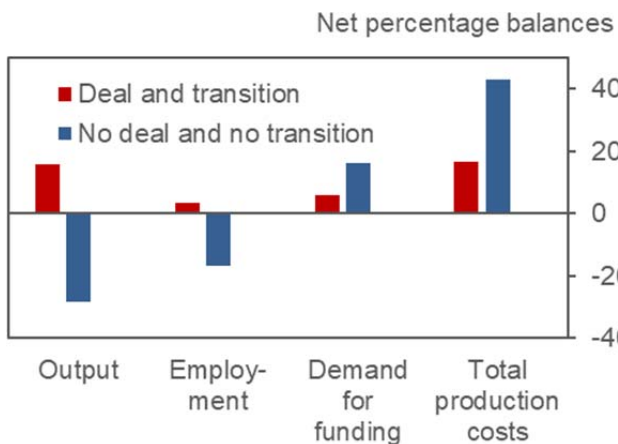
Chart 2: Brexit is an important source of risk for UK businesses



Sources: Decision Maker Panel and Bank calculations.

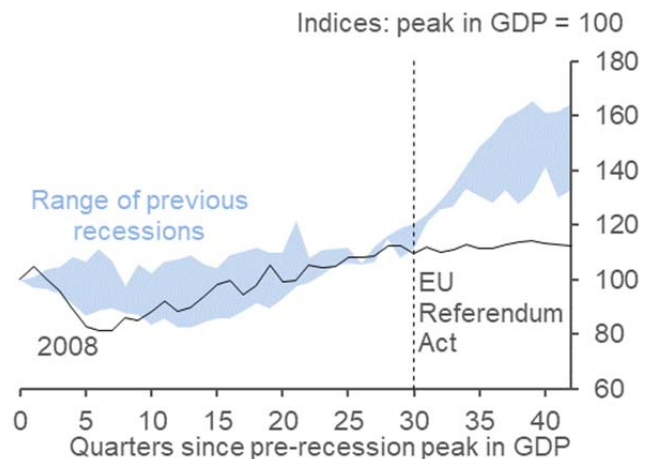
¹ See Bloom et al (2019) for more information on the Decision Maker Panel.

Chart 3: Firms say output and employment would fall in a no-deal, no-transition Brexit



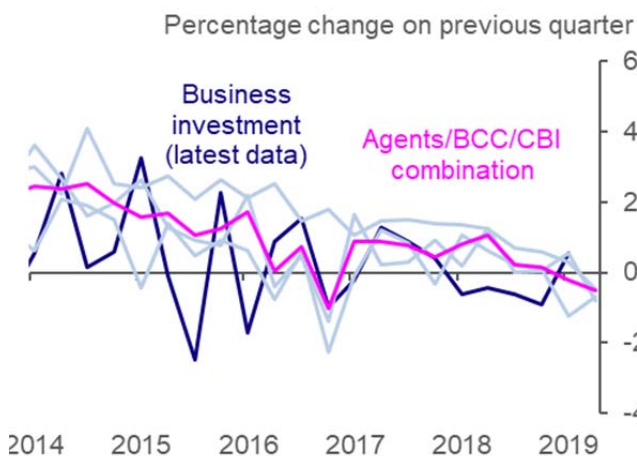
Sources: Bank of England and Bank calculations. See Bank of England (2018, 2019).

Chart 4: Investment has been weaker than in previous expansions



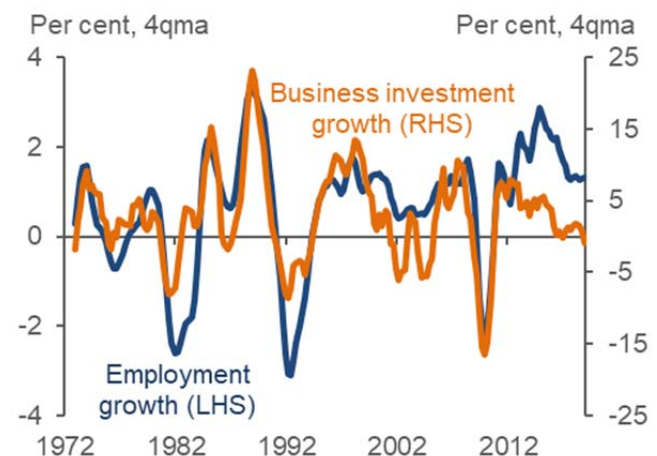
Sources: ONS and Bank calculations.

Chart 5: Surveys suggest underlying investment trend still negative



Sources: BoE, BCC, CBI, ONS and Bank calculations.

Chart 6: Investment growth unusually weak relative to employment growth



Sources: ONS and Bank calculations.

However, even then it was quite a bit weaker than in other countries, weaker still than in previous economic expansions in the UK (Chart 4). And it then started to decline. Business investment fell in every quarter of 2018 – outside recessions that’s the longest period of continual declines on record – and, although preliminary estimates suggest it recovered slightly in the first quarter of this year² the standard business surveys suggest the underlying trend is still negative (Chart 5).

This is remarkable at a time when the economy has been growing. What’s particularly striking is that firms have been cutting back on investment while adding jobs. Even as investment was shrinking, employment grew in every quarter of 2018, and quite strongly over the year as a whole (Chart 6).

² It’s possible that this was driven, somewhat perversely, by the same no-deal worries that pushed up firms’ inventory holdings (certainly there will have been similar incentives to expand warehousing and logistical capacity).

As I say, the impact of Brexit uncertainty on investment has been talked about quite a bit already and I'm not looking to give an exhaustive account of it today. One thing that helps to keep the talk relatively short is that I'll use a few symbols here and there (you're economists so I reckon I'm allowed to). As well as saving space it helps to make clear the effects at work and to give some idea of the orders of magnitude. That said, the points I'll try and make are, I think, perfectly intuitive.

I'll begin by reviewing exactly why it is that uncertainty can have such powerful effects on decisions that are costly to reverse. In doing so I'll emphasise that what really matters is not uncertainty per se but the scale of the downside risks in particular. This is a standard feature of the economics literature in this area. As long as it doesn't take too long to make an investment, once the decision to go ahead with it has been made, a firm can profit from upside events as and when they occur. The real value of delaying a project is in avoiding bad, loss-making outcomes.

I then want to say something about the perceived duration of the uncertainty. Does it make a difference if firms expect things to be resolved soon or only after a longer period of time? This is where it's helpful to construct a little "toy" model to work out what matters. In this set-up there's a discrete event whose outcome either raises or lowers the profitability of a sunk-cost (irreversible) investment project.

As is usual in these situations, it's the downside risk that gives the option of waiting its value. But there's also a cost to waiting because the firm is forgoing profits in the meantime. This cost increases with the expected duration of the uncertainty: the longer a firm thinks it's going to have to wait for things to be resolved the greater the profits foregone and the more likely it is that the firm will simply decide to get on with things and make the investment anyway. Conversely, delaying becomes more reasonable if the uncertainty is expected to last only a short time. A firm that has that expectation may as well wait to see how things turn out.

One implication of this is that you'd expect the impact of uncertainty on investment to intensify as we get closer to the date of resolution. Broadly speaking I think that's what we've seen in the data.

Another is that investment suffers more than it needs to if firms repeatedly expect things to be resolved sooner than they actually are. A repeated series of cliff-edges, each of which is expected to be decisive but in reality just gives way to the next cliff, is more damaging for investment than if it had been clear at the outset that the process will take time. This doesn't mean that resolving things soon, by any means necessary, is the better course. Actively choosing the very thing that businesses seem to fear the most is more likely to mean that investment projects that have so far been postponed will instead be cancelled for good. The point, rather, is that for a given duration of uncertainty, it's better that people are aware of it from the start, rather than being repeatedly surprised at how long the process takes.

One way of thinking about this situation is that periods of uncertainty – especially those with acute downside risks and that are expected to last only a short period of time – raise the required rate of return on new investments. They therefore have similar effects as a standard increase in the cost of finance: they incentivise firms to meet new demand with labour rather than capital. In the last section I'll go through some crude arithmetic to get some idea of the scale of such effects and, in that context, comment on the recent strength of employment and, more generally, on the weakness of productivity growth since the financial crisis.

The Value of Waiting for News

In economic theory, the negative impact of uncertainty on investment depends centrally on the assumption that capital spending is costly to reverse. A warehouse cannot easily or cheaply be turned into an office building; if a manufacturing company installs an extra production line, and demand for its product subsequently weakens, it can't then choose to lease the line to another firm; the same is true of specialised software for a bank or insurance company.

Clearly, this “sunk-cost” property of investment spending may in practice apply to some types of capital more than others. What we do know is that, without it, economic theory would have a hard time explaining why greater uncertainty depresses investment to the degree it does – or even at all.³

Conversely, once you do take it into account, the predicted effects can be quite powerful. Investment projects that would otherwise make a great deal of sense – because the income they're expected to generate easily exceeds the costs of financing them – will be avoided, or at least postponed, if the reversal costs are high enough and the uncertainty about those returns sufficiently acute.

Instead, it often makes sense to wait until the expected value of the project is sufficiently high that it covers not just the direct cost of the project but an extra margin of safety on top, something economists have called the “option value of waiting”:

Return on investment > cost of finance *plus* option value of waiting [1]

The greater this margin, the higher the profitability required of any new investment. As this hurdle rate goes up the number of new projects that can meet it declines.

The extra margin is well named because there's real value for a firm in being able to choose when to invest. Able to pick its moment, the firm can go ahead with an investment project when there's good news about future returns – and, equally, avoid committing itself when there's a risk the investment will make a loss.

³ Abel (1983) points out that, for given capital, a firm's profits are a convex function of the price of its product: they rise more in response to a given increase in the price than they decline as a result of the same-sized fall. This means that uncertainty about future prices actually raises expected profits, and therefore the incentive to invest.

In fact, it turns out that these downside risks are the more important determinant of the decision. The reason is that, as long as it doesn't take long to implement an investment, the firm can always respond to good news as and when it comes through. It has the same exposure to upside risks whether it invests in advance of good news or in response to it.

What it can't do, however, is to undo an investment it's already made if it subsequently gets bad news about future returns. The real value of waiting is that, if things do take a turn for the worse, the firm will have avoided the resulting losses. And it is this – the chance of avoiding the downside outcomes – that gives the option in [1] its value. Ben Bernanke, who did much to bring these issues to the attention of economists in a ground-breaking paper in 1983, called this the “Bad News principle”.⁴

What I want to do now is construct a very simple example that makes this point a little more precisely. And I'll do so in a way that allows us to think too about the effects of the perceived duration of uncertainty: does it make a difference if the firm expects things to be resolved soon or instead to endure for a long time? Though the example is highly stylised I think it can help shed some light on the impact of the ongoing uncertainty about Brexit.

We want to keep things as simple as possible, so in this example the only uncertainty surrounds a discrete event, at some point in the future, that has a lasting effect on the profitability of a particular investment project. Until the uncertainty is resolved (i.e. until the event occurs) the project yields a fixed rate of return R and can be financed at a known rate ρ .

When the event does occur the outcome is either good, in which case the project makes a proportionate gain of G (in expected-present-value terms), or a bad one, resulting in a present-value loss on the project of $L > 0$. Thus, if it were to leave its decision until the uncertainty is resolved, and it discovers the outcome of the event, the firm would go ahead with the project only if the news was good.

The probabilities of these outcomes, conditional on the event occurring, are $1-\lambda$ and λ respectively. As for the event itself, this has a per-period chance q of being realised. This means the expected duration of the uncertainty $E[T]$ is equal to $1/q$. If the firm expects to have to wait a long time for things to become clear this equates to a low value of q – there isn't much of a chance, in any given period, of the uncertainty being resolved. A high value of q corresponds to an expectation that the resolution is imminent.

⁴ There is a direct parallel between the nature of this extra margin required for real investment decisions and the value of an option in financial markets. A financial “call” option gives its owner the right to buy an underlying security for a pre-set price, known as the “strike”. If the price of the security in the spot market rises above that level the owner can “exercise” the option and buy it for less than it's now worth. In that sense he or she enjoys the same exposure to good news – to upside moves in the spot price – as the owner of the underlying security itself. The big difference is what happens when there's bad news (i.e. if the spot falls below the strike), the owner of the underlying security loses money but the owner of the option does not. That's simply because he or she can always choose not to exercise the thing. Thus the fundamental value of a financial call option arises from the ability to pick one's moment and avoid the downside risks that come with owning the underlying security.

Anyway, with these simple ingredients – and assuming, critically, that its prospective investment is irreversible – it turns out the firm’s decision rule is also simple. It will invest if and only if

$$R \geq \rho + q\lambda L \quad [2]$$

This is just the version of [1] that applies in this particular case.⁵ If there were no uncertainty ($q=0$) the investment would be justified so long as it offered any sort of excess return ($R > \rho$). But, given the uncertainty hanging over the decision, and in particular the risk that it might come to regret it, the firm needs an extra margin of safety – the “option value of waiting” $q\lambda L$ – before taking the plunge.

What can we say about this term and what are the implications, if any, for Brexit uncertainty?

The first thing to note is that, in common with all these models⁶, only the downside risk matters. The scale of the upside risk (G) has no bearing on the value of waiting and none, therefore, on the optimal timing of the firm’s decision. That’s because we assume it doesn’t take any significant time to implement the investment. The firm can therefore profit from the upside outcome (with a certain probability) whether it’s already invested by the time the event is realised, or instead chooses to wait until the good news actually comes through.

The real value of delaying the decision is that you avoid locking yourself in to what could be a bad outcome – and the greater the danger and scale of those downside risks (λ and L respectively) the greater the incentive to wait. Thus, although we talk in general terms about the impact of “uncertainty” on investment this is really a euphemism for downside risks specifically.⁷

In the case of Brexit you could spin this “Bad News” principle both ways. It’s worth recognising, for example, that weak investment doesn’t mean there aren’t potential upside outcomes. In principle businesses could well see positive opportunities from all this – it may just be that they have no reason to make the resulting investments until they actually know the final outcome.

On the other hand, what you can conclude from weak investment is that, whatever the scale of those upside risks, firms definitely see potential downside risks from Brexit ($L > 0$). We know that directly, of course, from the various business surveys (Charts 2 and 3 again). We know more specifically that the outcome firms view most negatively is that the UK leaves the EU without a deal or any agreed transition period. What the economics tell you is that it’s likely to be nervousness about these worst-case outcomes specifically that are deterring new investments, at least among businesses in the traded sector of the economy.

⁵ There’s quite enough Greek here already so I haven’t included the derivation in this talk: details are available on request.

⁶ I say “all” these models but this result rests on the assumption that it doesn’t take long to implement an investment and to start earning a return on it. If instead you think it requires a significant “time to build” the potential upside risks could matter for the investment decision. There’s some incentive in that case to having the investment in place by the time the news is revealed, and the decision will depend on both L and G . See, for example, Bar-Ilan and Strange (1996).

⁷ The toy model here, with only two possible ways in which the uncertainty can be resolved, is as simple as it could be. But the “Bad News Principle” applies more generally, including in cases where there’s a continuum of possible outcomes. Boyarchenko and Levendorskii (2007) give a good description (see in particular section 1.3 for a brief summary). Dixit and Pindyck (1994) is a more readable account of the general approach.

A related point is that not all reductions in uncertainty are beneficial. In particular, guaranteeing what firms themselves see as the worst case outcome (in the simple model that would mean setting $q = \lambda = 1$) is unlikely to improve matters even if it “resolves the uncertainty”. Quite the opposite: it would mean only that projects that have so far been postponed, precisely for fear of such an outcome, would then be cancelled for good.

Another set of implications arises from the expected duration of the uncertainty ($E[T] = 1/q$). It’s helpful in this respect to re-express [2] as follows:

$$E[T] (R - \rho) \geq \lambda L \quad [3]$$

Writing the result this way makes its interpretation that much more intuitive.

On the right-hand side is the benefit of waiting until the event is realised, i.e. the (probability-weighted) loss the firm could thereby avoid.

On the left-hand side is the cost of waiting, namely the excess return the investment would earn in the meantime. And the longer the wait (the higher the expected duration of the uncertainty $E[T]$) the greater the foregone income is likely to be. If the firm expects a really long delay before the news comes through (high $E[T]$, low q) it might well decide it just has to get on with things and make the investment anyway. If, on the other hand, it thinks there’s going to be an imminent resolution (high q , low $E[T]$), there is every incentive to wait until that actually happens. In the meantime only extremely high-return projects would get the go-ahead.

One general implication of this is that empirical estimates of the impact of uncertainty on investment, which generally assume that the effect is purely contemporaneous – investment today is a function solely of uncertainty today – are (strictly speaking) an over-simplification. At least in principle it will also depend on how long businesses expect any uncertainty to endure: the shorter the expected duration the greater the predicted impact. I doubt this would ever be straightforward to test empirically. As hard as it is to measure uncertainty very precisely it’s obviously harder to gauge accurately how long people expect that uncertainty to last. But the distinction may nonetheless matter on occasion.

One such occasion is when there is thought to be a particular date at which important information is likely to be revealed. If so, then [3] suggests that the effect of uncertainty on investment should intensify the closer

one gets to that point. As the remaining time shortens the perceived cost of waiting for news falls with it.⁸ The predicted effect is quite powerful: at least in this highly stylised set-up, halving the expected duration of the uncertainty (i.e. doubling q) has the same impact on the required rate of return on new investment as doubling the chances or scale of the bad outcome.

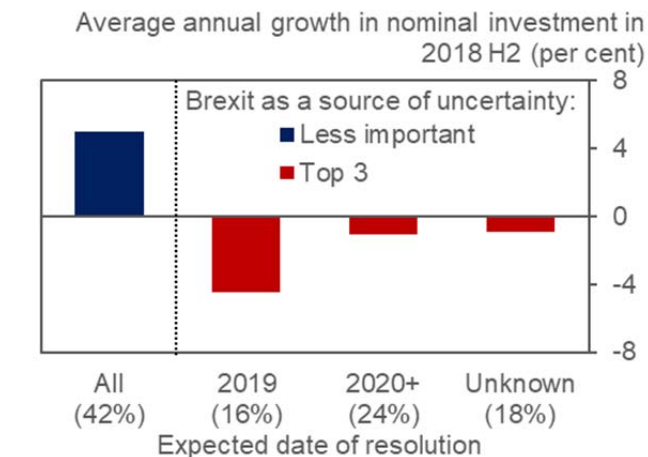
Directionally, at least, I think the evidence provides some support for this effect. The fact that protracted declines in investment were seen only in 2018, some time after the referendum but increasingly close to (what was expected to be) the exit date in March 2019, is consistent with it.

So too is Chart 7. Taken from the latest Decision Maker Panel survey, it suggests that the firms who've cut back the most on their investment spending tend to be those who also expect a relatively early resolution to Brexit. Firms who think the process will take longer – and obviously those (in blue) who don't consider Brexit an important factor in their decisions to begin with – have been less aggressive in their response.

One implication is that the overall hit to investment is worse than it need be if firms have unrealistic expectations about how rapidly the situation is likely to be resolved. The Brexit process – and by that I mean not just the exit agreement but the negotiation of (and transition to) future trading agreements as well, with the EU and with other countries – will take the time it takes and I don't pretend to know more than the next person how long that might be. The point here is that, for any given duration of uncertainty, the impact is worse if, along the way, firms continually expect things to be resolved sooner than they actually are.

Just to be clear, one should not draw the conclusion that a rapid resolution of uncertainty is always desirable, no matter how that's achieved. As I said earlier, if investment has been postponed for fear of what firms see as a bad outcome, guaranteeing precisely that outcome will probably make things worse. It's likely to mean that projects delayed will instead be cancelled. The point is simply that the impact on investment of a given period of uncertainty is worse if, erroneously, firms keep believing that it will end sooner than it's actually likely to.

Chart 7: The reduction in investment has been driven by firms that expect a resolution soon



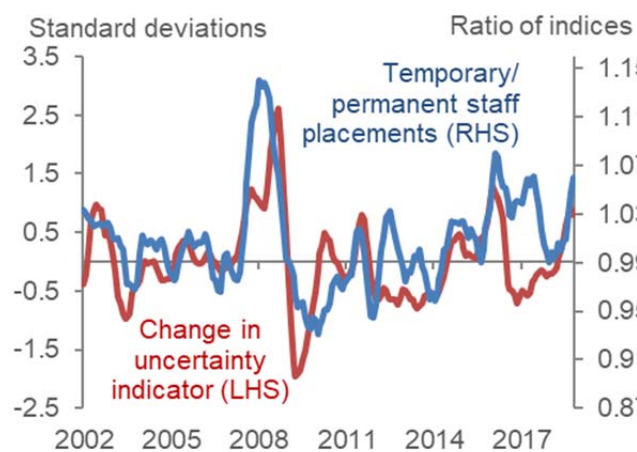
⁸ The particular way I've set things up here means the date at which the news arrives is itself uncertain – it happens with probability q every period. But it's easy enough to model it instead as a fixed, known date in the future. The results are quantitatively a bit different – and marginally less easy to write down – but qualitatively they're exactly the same.

The cost of capital and employment

The underlying point through all of this – that downside risks have particularly marked effects on decisions that are costly to reverse – is, I think, perfectly intuitive. One’s naturally wary about decisions that involve a degree of commitment but uncertain outcomes. Buying a house, taking a particular job, even getting married⁹: these are all decisions that are costly to reverse, to one degree or another, and that therefore require an extra degree of surety to be taken.

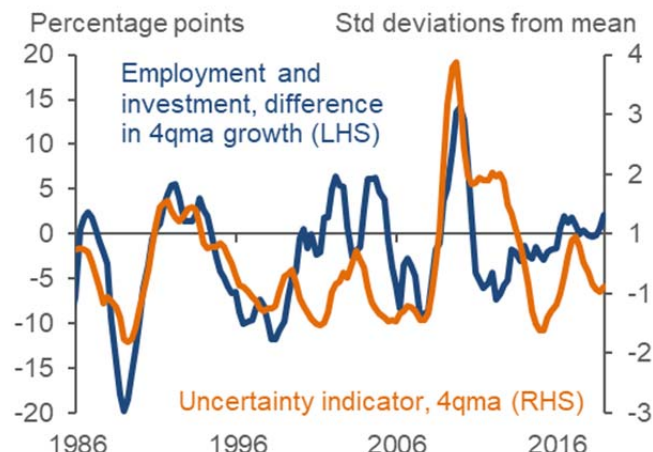
You can also find examples of the same phenomenon within the economic sphere but unrelated to investment. Chart 8, for example, plots changes in our series on uncertainty against the ratio of two particular indices for hiring intentions – one for temporary posts, the other permanent – taken from the KPMG/REC employment survey. As you might expect, firms’ hiring intentions lean more towards temporary rather than permanent jobs, because the former involve less of a commitment, when they’re more uncertain about the future.

Chart 8: Employment growth skews towards temporary jobs when uncertainty rises



Sources: KPMG, REC, IHS Markit, Bloomberg Finance L.P., CBI, Consensus Economics, Dow Jones Factiva, Eikon from Refinitiv, GfK (research on behalf of the European Commission) and Bank calculations.

Chart 9: More uncertainty boosts employment relative to investment



Sources: ONS, Bloomberg Finance L.P., CBI, Consensus Economics, Dow Jones Factiva, Eikon from Refinitiv, GfK (research on behalf of the European Commission) and Bank calculations.

But the degree of commitment is bound to be greater, compared with job creation of any kind, for new capital investment. And it’s clear in the data that it’s investment that’s particularly susceptible to uncertainty, much more so than employment. One way of demonstrating that is Chart 9. The blue line in this graph is the difference between the growth rates of employment and investment. The spread between the two is clearly correlated with uncertainty and, in that context, the fact that employment growth has held up much better than investment in the past year or so is less surprising. What the generic relationship in [1] tells you (as

⁹ Even the dictum that one “marries in haste [only to] repent at leisure” could perhaps be seen, if only to an unromantic economist, as a lesson about the option value of waiting.

does its particular incarnation in [2] and [3]) is that greater uncertainty – an increase in downside risks in particular – has exactly the same effect as an increase in the cost of finance or a tax on capital income: it penalises investment relative to employment.

What is the scale of this effect? Well if you go through some crude numbers, based on existing estimates of how the supply side of the economy works¹⁰, those would tell you that a proportionate increase of a tenth in the effective cost of adding new capital – from 10% to 11%, say – would eventually raise the demand for labour, for given output, by somewhere between 1½ and 2%.

I say “eventually” because, at any one time, there are always some firms who have spare capacity. For them, employing more capital means using more of what they already have. That’s obviously less costly than installing new capacity. But over time, the average firm will tend to see increases in demand and it will eventually face the choice of whether to meet those increases by expanding capacity or hiring more people.

A sustained rise in the effective cost of capital, whether through a rise in interest rates or the uncertainty premium we’ve been looking at today, will make them more inclined to choose the latter rather than the former. The eventual effect is to lower productivity.

I think a rising risk premium may have been having an impact of this sort, at the macro-economic level, ever since the financial crisis, more intensely over the past couple of years.

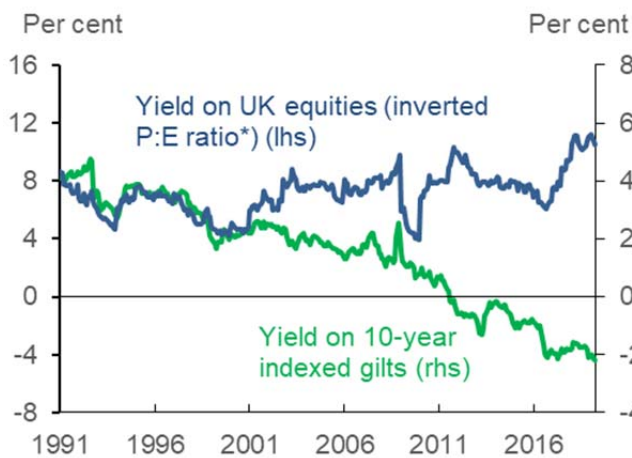
Consider, for example, Charts 10 and 11. Chart 10 I’ve used on a number of occasions. The green line is the risk-free rate of interest (the yield on 10-year indexed gilts). The blue line is a measure of the cost of finance for risky investments: it’s the profits of UK-quoted companies relative to their market value (debt as well as equity). The graph shows that, despite a protracted and significant decline in risk-free interest rates, firms have had to generate significantly more profits than in the past to raise a given amount of finance. The spread between the two lines is a measure of the risk premium on new investments, and it’s gone up significantly in the past few years, including since the EU referendum in 2016.

Chart 11 carries a similar message. Here the orange line is a similar measure of that spread, between the rate of profit for private-sector firms¹¹ and the yield on gilts. The blue line is the rate of growth of their investment spending.

¹⁰ In the simplified way that macro-economists sometimes use to describe the supply side of the economy, using a so-called “production function”, the elasticity of productivity with respect to the cost of capital – the proportionate response of the first to the second – is the product of two numbers: the share of national income going to capital (as opposed to labour), and something called the “elasticity of substitution” between the two inputs. In the data, the first is around one third; empirical estimates for UK put the second at around one half. Multiply the two and you get a figure of around one sixth.

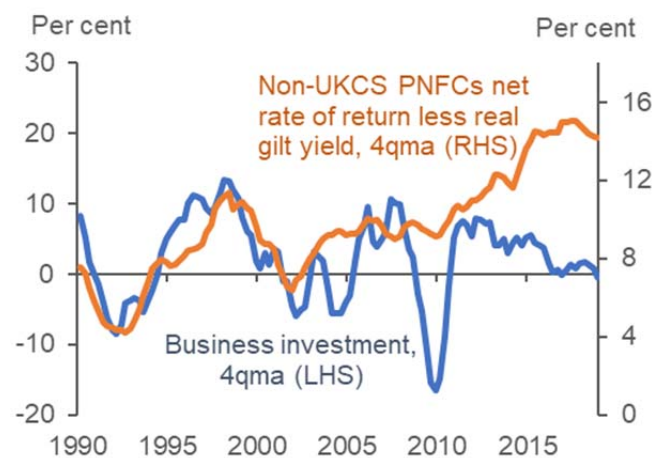
¹¹ The two charts use slightly different measures of profitability. The blue line in Chart 10 measures profits of UK-quoted firms (including some that have operations outside the country) and, as the denominator, the market value of their capital (debt plus equity). Chart 11 subtracts the gilt yield from a national accounts measure of profitability: profits of firms located in the UK relative to the book value of their capital. But they’ve behaved in a similar fashion and convey very much the same message.

Chart 10: The required rate of return for UK firms has risen even as risk-free yields have fallen



Sources: Bank of England, Eikon from Refinitiv, TradeWeb, Bloomberg Finance L.P and Bank calculations.
 * Adjusted for changes in leverage.

Chart 11: The combination of rising profit margins, falling investment growth suggests significant increase in risk premium



Sources: Bank of England, ONS and Bank calculations. UKCS are UK continental shelf companies.

Before the crisis, rises in profitability (relative to interest rates) would lead to faster investment growth. That's not been true in the past few years. Profits have been very healthy, relative to the existing stock of capital. The spread between the rate of return and the risk-free interest rate has risen significantly, from around 10% in the middle of the last decade to close to 15% today, a proportionate rise of 50%. On the face of it the financial incentive to expand capacity is very strong.

Yet growth in new investment has been falling, and in the past year or so has turned negative. To me this suggests that even the rise in the profitability we've seen has not been enough to compensate for the increase in the risk premium that's been occurring in the background. And if you take seriously the crude estimates we've just been through, you might expect that to have had a significant effect on productivity growth.

A brief summary

Let me try and sum up.

Business investment fell in every quarter last year and surveys suggest the underlying trend is still negative. This is remarkable at a time when profits are high, when the economy's not been in recession and when employment has been growing strongly. A plausible explanation is that rising uncertainty has acted like an extra hurdle on the required rate of return for new capital projects, deterring expansion in productive capacity and encouraging firms to meet new demand with labour instead. The economics tells us that, because such spending is costly to reverse, perceived downside risks to future profits can act as a powerful disincentive to

new investment projects. If something's easier to get into than out of, you naturally worry about what might subsequently go wrong.

Those perceptions may have been worsening for some time. The evidence suggests that we've been living with a high risk premium on new investment for several years. The spread between the rate of return on risky investments and the risk-free rate of interest has been historically high since the financial crisis. I think this has probably contributed to lacklustre investment and weak productivity growth over that period.

But the risk premium seems to have taken another leg up since the EU referendum in 2016. And if you believe the surveys, the perceived downside risk in this case – the thing the firms seem to view most negatively – is a no-deal, no-transition outcome to Brexit.

The economics also tells you that the value of waiting for relevant news – and therefore the disincentive to invest in the meantime – is higher if you think that news is going to arrive relatively soon. This helps to explain why the impact of Brexit uncertainty on investment seemed to intensify as we got closer to the assumed exit date of March 2019. It also explains why the firms most reluctant to invest have tended to be those that expect an early resolution to the Brexit process.

It would be wrong to conclude from this that the best thing for investment is to resolve this uncertainty as soon as you can, by any means necessary. Deliberately choosing the outcome firms say they view most negatively is more likely to mean that capital projects that have so far been deferred are then simply cancelled. And however long the process actually lasts, investment is likely to perform better if firms don't continually expect an early resolution in the meantime.

Thank you.

References

- Abel, A. B.** 1983. "Optimal investment under uncertainty". *American Economic Review*, Vol. 73, No. 1, pp. 228-233.
- Bank of England.** 2018. "Agents' survey on preparations for EU withdrawal and results from the Decision Maker Panel survey". Available at: <https://www.bankofengland.co.uk/report/2018/agents-survey-on-preparations-for-eu-withdrawal>.
- Bank of England.** 2019. "Agents' update on business conditions". *Box 5 in the May 2019 Inflation Report*. Available at: <https://www.bankofengland.co.uk/inflation-report/2019/may-2019/demand-and-output#agents>.
- Bar-Ilan, A. and Strange, W. C.** 1996. "Investment lags". *American Economic Review*, Vol. 86, No. 3, pp. 610-622.
- Bernanke, B.** 1983. "Irreversibility, uncertainty, and cyclical investment". *The Quarterly Journal of Economics*, Vol. 98, No. 1, pp. 85-106.
- Bloom, N., Bunn, P., Chen, S., Mizen, P., Smietanka, P., Thwaites, G., and Young, G.** 2019. "Brexit and uncertainty: insights from the Decision Maker Panel". Bank of England *Staff Working Paper No. 780*. Available at: <https://www.bankofengland.co.uk/-/media/boe/files/working-paper/2019/brexit-and-uncertainty-insights-from-the-decision-maker-panel.pdf>.
- Boyarchenko, S. and Levendorskiĭ, S.** 2007. "Irreversible decisions under uncertainty: optimal stopping made easy". Springer-Verlag, Berlin.
- Dixit, A. and Pindyck, R. S.** 1994. "Investment under uncertainty". *Princeton University Press*.