

Extreme risks

“ The memorable events of history are the visible effects of the invisible changes in human thought ”

Gustave Le Bon, *The Crowd*, 1895

Introduction

Economics concerns the allocation of scarce resources. No scarcity, no economic problem – everyone can have as much as they desire. In more colloquial terms, economics is about how to portion out the cake. As dividing a growing cake is a much more pleasant problem than dividing a static cake (or, heaven forbid, a shrinking cake), much of economics is about growth.

Capitalism has become the dominant economic framework for engendering world growth. (By capitalism, we refer to the risking of private capital for the prospect of reward and this implies certain things such as markets, property rights and the enforcement of contracts. We make no assumption regarding politics – for example, democracy.) The end of capitalism is therefore the ultimate extreme risk – constrained growth and the end of investing!

In this paper we consider investment risks – those that could affect asset returns (and, in some cases, the associated liabilities). We do not consider other extreme risks such as from longevity, operations, processes or systems.

In addition to the end of capitalism, we identify 14 further extreme risks which, while very unlikely, would impact economic growth and asset returns, should they occur. We do not claim this to be an exhaustive list.

All 15 risks are described in the appendix (and, for the interested reader, a fuller version of the appendix is available on request) but for the sake of brevity we group them into three categories – financial, economic and political (including ‘other’) – and we comment on each of these categories.

The events of the last two years have demonstrated that risk management cannot afford to stop at the 95th percentile (VaR_{95}). We need to find a way to include very unlikely, but potentially high impact, events.

Our approach

This paper starts the process of considering extreme risks, but does not offer a complete solution. A complete solution combines a qualitative understanding, quantitative analysis (modelling) and a cost-benefit analysis of possible hedging strategies.

We start with the qualitative understanding – ‘what could cause this event?’, ‘is it plausible?’ and ‘assuming this event occurred, what would be the consequences?’

This approach is directionally in line with the thinking of Nassim Nicholas Taleb, author of *The Black Swan*, who argues that we should give up on financial modelling as “no model is better than a bad model”. Taleb advocates the use of empirically-based rules of thumb. Some of the issues involved with quantification are considered in the ‘Extreme value theory’ sidebar on page 6.

Financial

Financial extreme risks essentially revolve around solvency. Can the financial institution pay its debts with available cash? The interconnected nature of the modern financial system and the (still) high levels of leverage mean that insolvency for one institution can quickly become a systemic problem.

The primary triggers for financial risks (solvency) are falling asset prices and falling incomes. Financial risks can be self-generated (falling asset prices) and transmitted to the real economy, as we have recently seen. Risks can also be generated by a recession in the real economy which reduces incomes (corporate incomes through falling sales and/or household incomes through unemployment) and transmitted to the financial sector through default on loans.

Whatever the trigger, financial risks will generally mean that most asset prices decline, as whatever can be sold is sold to raise cash (‘correlations tend to one’). There is almost certain to be a flight to quality, meaning the highest quality bonds (sovereign) should outperform other assets. Historically, gold has been a good hedge against financial turmoil (as, if capitalism were to end, gold is probably more useful in the following regime than security certificates).

Economic

The economic extreme risks are less homogenous than the financial risks, ranging from a deflationary depression to hyperinflation and a return to a gold standard.

The deflationary depression risk implies that government actions to date will prove to be incapable of returning the

economy to sustainable growth. This would be a very bad environment for asset prices and it is likely that there would be a flight to the safety of sovereign (nominal) bonds.

The other economic risks essentially assume that government actions are successful, but at a price. A currency crisis could be profited from by holding unhedged foreign assets, but is likely to be highly disruptive to domestic asset returns at least in the short term – the crisis will have been triggered by some form of economic malaise which is likely to be reflected in lower asset prices. At a more micro level, the equities of exporters should perform better than those of importers.

Should stimulating the economy require government debt to grow to an unsustainable level, then we would have the prospect of sovereign default or hyperinflation. Either of these would be intensely bad for asset returns, including sovereign debt. (It is probably best to assume that inflation-linked bonds would be defaulted on in hyperinflation.) It is possible, but not certain, that gold would act as a hedge against these risks, particularly as they would increase the likelihood of a return to a gold standard.

Political and other

Our third category of extreme risks comprises those which do not have financial or economic causes. Most derive from politics (policy decisions) but we include climate change and killer pandemics.

As a consequence, we stress that there is a very high degree of uncertainty attaching to any estimate of the likelihood of occurrence. They will also tend to be much harder to monitor and predict – with the exception, perhaps, of protectionism (easy to see happening and the consequences are well understood).

In most cases, these risks will be hard to hedge. For example, hedging the break-up of the euro may involve the use of credit default swaps (CDS) contracts, which introduce different risks. Adding food and water exposure to a portfolio may hedge climate change (and at a pinch, war) but might run the risk of confiscation in precisely the circumstances in which they became most valuable.

How likely? How bad?

Having briefly considered the risk categories, the obvious questions become ‘how likely?’ and ‘how bad?’ The technically correct answer to these questions is ‘we don’t know’. That said, we make some further comments in the appendix, and we summarise our subjective views in Figure 1.

Rather than attempt to give each risk a probability (the quantitative route), we assign them one of three risk categories – ‘low’, ‘very low’ and ‘very, very low’. Each category has a rule of thumb for the likelihood of occurrence of 1:10, 1:20 and 1:100 respectively. (For the technically minded, this can be thought of as describing a high alpha power law for the distribution and implies we believe these events should be considered far more likely than if a Normal distribution were used.)

We also assign each risk to an impact category: high implies a significant impact on most asset and liability values, medium a material impact on some values, and low an impact on a few values where the significance could vary.

Ranking

We use a subjective scoring system to derive a ranking of these risks (see Figure 2 overleaf). The scoring combines the impact and the risk together with the degree of uncertainty in assessing the risk. For example, we are

much less confident in assigning a probability to a major war than we are to an insurance crisis.

Assuming this approach has merit, the ranking serves as a priority list for considering the various risks and whether any portfolio hedging activity could be or should be undertaken. This should be seen as pragmatism as, of course, holistic risk management should consider all risks (including those we do not discuss here).

We also show an ‘association’ matrix (see Figure 3 overleaf). We use the term ‘association’ rather than correlation to communicate that this is a qualitative assessment of whether events are likely to occur together (with one perhaps being a minor or major cause of the other) rather than a quantitative assessment of past data.

The matrix uses a colour (and letter) code to indicate the degree of association. This clearly indicates that we see the financial risks and several of the economic risks to be very closely associated. For some of them the causality could run in either direction, but in any case if one were to occur it would materially raise the risk of others occurring.

Figure 1 | Extreme risks - likelihood and impact

		Risk					
		Impact	Low	Very low	Very, very low		
Financial	High					Low	Could be expected once every 10 years from current conditions
	Medium		Excessive leverage	Banking crisis		Very low	Could be expected once every 20 years from current conditions
	Low			Insurance crisis		Very, very low	Could be expected once every 100 years from current conditions
Economic	High		Depression	Hyperinflation		Impact	
	Medium		Currency crisis	Sovereign default		High	Direct and significant impact on most asset and liability values
	Low				End of fiat money	Medium	Direct and material impact on some asset and liability values
Political	High			Climate change	End of capitalism		
	Medium		Political crisis	Disunity in Europe	Major war	Low	Direct impact on few values, variable significance
	Low		Protectionism		Killer pandemic		

A second cluster can be seen between the political and economic risks, indicating that our economic wellbeing will be strongly influenced by political developments. For example, we assess that protectionism and depression have a high association. The primary causality is likely to run from depression to protectionism but we would also argue there is a weak causality in the other direction, in that greater protectionism would weaken economic growth and increase the risk of depression.

Also clear from the matrix is that climate change and killer pandemic are truly independent risks. They may be loosely related (a hotter climate being a better breeding ground for bugs, perhaps) but otherwise only intersect with political crisis (where the causality could conceivably work either way).

Hedging

As noted above, this paper addresses the qualitative aspects of extreme risks and so our comments on hedging are kept to a high level. Further work would be

necessary to establish the likely costs and benefits for hedging action in a specific context.

The first observation is that not all of these extreme risks can be hedged or any hedge used is likely to be very imprecise. For example, in the appendix we note that the outcome of a killer pandemic is highly uncertain – what proportion of the population would it kill? What age group would suffer disproportionately? – and therefore the impact on assets and liabilities is unknowable.

Our second observation would be that it will be necessary to decide how effective you want the hedge to be. To explain, if the bad event happens would you want to be left fully funded, or would you be happy if you had 10 per cent of your assets left? The second option is much easier to achieve than the first, as you would simply move say, 10 per cent of your portfolio into a hedging asset (we briefly alluded to gold and high quality bonds for some of the risks) – we assume the other assets become worthless.

Figure 2 | Extreme risks - ranking

Risk ranking* as at 30 June 2009			
Rank	Risk	Description	Possible hedge
**1	Depression	Debt-deflation trap; falling growth and incomes	Globally-diversified long-dated Sovereign nominal bonds
2	Hyperinflation	Extremely high inflation	Real assets, for example gold, globally-diversified inflation-linked bonds
**3	Excessive leverage	Debt burden cannot be serviced from income	Gold, reserve-status currency
**4	Currency crisis	Extreme movement between floating rates	Gold, foreign assets
**5	Banking crisis	Balance sheets cannot absorb another shock	Nominal sovereign bonds (medium duration)
6	Sovereign default	Default by a developed country on its debt	Country insurance (for example CDS)
7	Climate change	Diversion of capital to mitigation uses	No general hedge
8	Political crisis	Rise in power of extremist groups	No obvious hedge
**9	Insurance crisis	Insolvency within insurance sector	Nominal sovereign bonds (medium duration); short insurance equity
10	Protectionism	Reversal of movement towards free trade	No general hedge
11	Disunity in Europe	Break-up of the euro	Long Germany (hedged)
12	End of capitalism	Move to socialism and closing of markets	Gold
13	End of fiat money	Return to a gold standard	Gold
14	War	A major global conflict	Long neutral countries
15	Killer pandemic	Contagious disease with very high mortality	Long pharmaceutical equities, short airline equities

* Our subjective measure based on the impact, the risk and the degree of uncertainty in assessing the risk level.

** We are more confident in being able to attach a probability to these events.

More complete hedging increases the complexity in a number of ways:

- The carrying cost of the hedge is likely to be higher.
- It is almost certain to require the use of derivatives, and therefore thought needs to be given to whether the counterparty would be willing and able to pay out if the bad event happened.
- As Keynes warned, it is better to fail conventionally than to succeed unconventionally. If a single, or a few, institutional investors become 'super rich' relative to others through successful hedging, there would be a danger that it/they would be targets for special levies, taxation and/or confiscation.

That said, derivatives provide much greater flexibility and more precise targeting of risks. They also do not require much capital, leaving the bulk of the portfolio untouched.

Conclusion

Investors will (usually) be happiest in periods of stronger economic growth, when the return on assets is likely to be

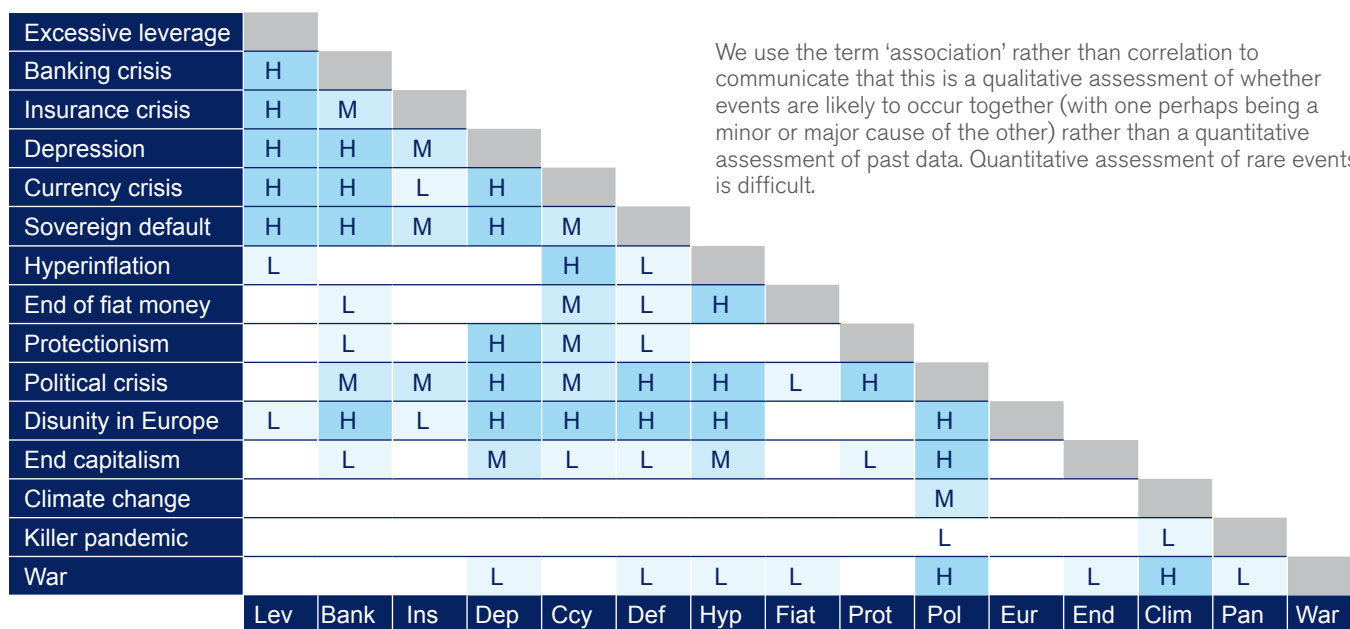
highest. In this paper we have identified a number of risks that could interrupt future growth and have briefly noted how different assets may fare in the different events.

GaveKal Research frequently talk of the "five deadly sins" when it comes to economic growth: (1) protectionism, (2) increases in regulation, (3) monetary policy mistakes, (4) increases in taxation and (5) war¹. We have covered the first and last in this paper. The remaining three are public policy issues and will both influence the risks identified in this paper and be shaped by the shifting likelihood of the different risks through time. We will consider public policy issues in greater detail in a future paper.

While the risks identified in this paper are remote, the impact on portfolios if they did occur would be significant. We believe the recent crisis has shown that risk management based solely on volatility (which includes VaR₉₅) is not sufficient. We also need to be aware of risk in the extremes. We would be happy to discuss possible monitoring or hedging arrangements suitable for particular client contexts.

¹ For example, GaveKal Daily report, 30 November 2005.

Figure 3 | 'Association' matrix



We use the term 'association' rather than correlation to communicate that this is a qualitative assessment of whether events are likely to occur together (with one perhaps being a minor or major cause of the other) rather than a quantitative assessment of past data. Quantitative assessment of rare events is difficult.

H	High degree of association. Could be causality in both directions
M	Medium degree of association. Could be causality in one direction
L	Low degree of association. A possible contributing, rather than casual, factor
	No, or very low, association

Extreme value theory

Extreme value theory (EVT) is a specialist branch of statistics that attempts to make use of what little information there is concerning extreme outcomes. (By definition, they do not occur very often, so there is little historical information.)

In many respects it is a formalisation of the work of actuaries in the insurance field, who have long had to attempt a quantification of catastrophic loss.

A key component of EVT is the extreme value theorem, which is a corollary of the central limit theorem. (The distribution of the averages of samples from a population will tend towards a Normal distribution, irrespective of the shape of the population distribution.) In a similar way, the extreme value theorem shows that there are three ways a tail can decay. Knowledge of the general properties of the subject being studied allows the selection of the appropriate tail distribution. Choosing a distribution for the tail solves the paucity of historical data problem.

That is the theory. In practice, it is likely that more than one tail distribution is consistent with the historical data and therefore a choice has to be made. The one thing we know about that choice is that it will yield very different probabilities for the occurrence of the extreme event – which one is correct? We do not think it is possible to know.

In addition, more sophisticated models require more input in terms of parameters. We are then back to the problem of either using a very small historical data set to derive the parameter values, or we must use subjectivity. It is not clear that the results will necessarily be superior to using a simple model with a subjective overlay.

However, and as an aside, the field of EVT has already thrown up some interesting findings. For example, there is some evidence that for equity markets the negative tails are statistically significantly fatter than positive tails. (This is not the case for all countries, and the effect is more pronounced for emerging markets than developed markets.)²

² LeBaron, Blake D and Samanta, Ritirupa, Extreme Value Theory and Fat Tails in Equity Markets (November 2005). Available at SSRN: <http://ssrn.com/abstract=873656>

Watson Wyatt Limited Investment Consulting

Thinking Ahead

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Appendix

Financial

Excessive leverage

What is this extreme risk?

The use of leverage is useful for society in that it allows capital-constrained entrepreneurs to contribute to economic growth. However, it is now clear that there is some level of leverage that is optimal, and leverage beyond this implies a 'social loss'.

The risk is that the use of leverage in the whole society exceeds a sustainable level beyond which the debt can no longer be serviced from income (or no safety margin exists), which triggers a self-reinforcing fall in asset values.

We now have public sectors increasing their leverage (debt to GDP ratios) and so believe the risk of excessive debt will persist for a number of years.

What are the consequences?

Excessive leverage typically occurs with speculation, where the intention is to pay back the debt when the speculative asset has been sold for a higher price. The risk is 'latent' in that debt can remain too high, but serviceable, provided that asset prices do not decline.

Nevertheless, falling asset prices can trigger a self-reinforcing cycle and it is not automatically possible to reduce leverage even if desired. This would cause the financial markets to stop functioning, triggering a similar reaction in the real economy to the one we have just seen – falling growth, employment and incomes and the possibility of depression.

Major banking crisis

What is this extreme risk?

This risk implies that government action so far has been insufficient to secure the banks against possible future developments.

Developments that could threaten future bank solvency could include: (1) a continued drop in real estate prices, (2) increased corporate defaults and (3) poor economic conditions in general.

What are the consequences?

The response is highly likely to be the same as seen recently: a seizure within the financial markets triggering a flight to safety; a swift transmission to the real economy threatening trade and businesses; reduced economic growth as the availability of credit evaporates; and the possibility of depression.

The possibility of nationalisation of the banks would be greater. However the issue would then be the state of government finances at that point in time, and therefore whether this action was possible without triggering one of the other (economic) risks (for example, sovereign default) identified in this paper.

Insurance crisis

What is this extreme risk?

This risk is the insolvency of the insurance industry — that is, the assets are (become) smaller than the liabilities. This could occur through inadequate capitalisation of risky asset positions (the value of risky assets fall more than anticipated and do not recover) or through 'basis' risk (the safe assets held against the liabilities underperform, for example through sovereign default).

What are the consequences?

We would expect a similar unfolding of events to that of the recent banking crisis, namely 'strong' insurers would be encouraged to take over failing insurers. Failing that, governments would provide some form of backstop (if able to). Given its nature, insurance is more likely to be affected than non-life. The main consequence would be lower receipts by the private sector (pensions, savings plans, and so on) and therefore lower consumption.

Economic

Depression

What is this extreme risk?

There is no standard definition of a depression, although it is generally taken to be a deep and protracted trough in output/GDP.

The current risk of depression appears to have been reduced through policy action, but remains an extreme risk, in that it may not be possible for governments to counteract any future drop in demand, should that occur.

There has been an extended period of over-consumption (by Western consumers) meaning that businesses have built productive capacity to satisfy a level of demand that is unlikely to be reached for a number of years, as Western households increase their savings rate.

What are the consequences?

The primary consequence of a depression is typically a sharp and prolonged increase in unemployment. (The depth of the trough means that a long period of recovery is required before there is pressure to hire new workers.) The subsidiary effects are therefore a drop in consumption, restriction of credit, shrinking output and investment and numerous bankruptcies. Depressions can trigger deflation or hyperinflation, adding further complication.

Excessive leverage can interact with depression – a self-reinforcing fall in asset values can cause further defaults, bankruptcies, falling incomes and rising unemployment, causing or prolonging economic depression.

Currency crisis

What is this extreme risk?

'Currency crisis' is an alternative term for 'balance of payment crisis' and is therefore, technically, the breaking of a fixed exchange rate. In a looser sense, it can also mean an expectation of a significant self-fulfilling devaluation.

Ideally economic management is used to maintain balance. This could be through policies to make domestic business more efficient (raising exports) or changing interest rates to attract/deter capital inflows. Therefore the movement in the exchange rate can be thought of as a safety valve that had to blow because other (painful) economic adjustments were not made – for example, raising interest rates and/or taxes. For a fixed exchange rate, this will occur when the central bank runs out of reserves and can no longer defend the exchange rate.

What are the consequences?

A currency collapse severely reduces a country's purchasing power and hence wealth.

To the extent that domestic borrowing has occurred in foreign currencies, the cost of servicing that debt will rise dramatically, and hence immediately increase the risk of default.

The direct impact on asset returns is through the currency – domestic investment in domestic assets will be unaffected; domestic investment in foreign assets will benefit substantially if unhedged; investment by foreigners in domestic assets, if unhedged, will suffer very poor returns. The indirect effects are more complicated as the crisis will only have occurred because of some underlying economic imbalance.

Sovereign default

What is this extreme risk?

Sovereign default is the non-payment of interest or return of principal by a sovereign borrower. There is concern about the current size of budget deficits and hence sovereign debt issuance. However public debt is starting from a relatively low proportion of GDP and what matters is the shape of the debt-to-GDP trajectory. Much better is a rapid increase that flattens off and then falls as economic growth resumes allowing the government to rebuild its balance sheet. The bad scenario is a ratio that continues to rise because economic growth remains muted.

We believe sovereign default is more likely if economic growth remains stuck at a low level; if taxes are not or cannot be increased; and if governments do not (or cannot) reduce spending. The likelihood also increases when the taxes are paid by workers who do not believe it is their issue (the next generation).

What are the consequences?

Directly, the defaulting borrower benefits and has more money to spend on consumption. The lender permanently loses that capital.

More indirectly, the costs associated with sovereign default fall into two broad types – penalty costs and output costs. Penalties are applied by external creditors on the cost or ability of defaulters to access future finance. So increasing consumption today may be at the expense of reducing consumption tomorrow.

Output costs refer to the drop in production and therefore consumption of the defaulting nation. As domestic banks tend to be large holders of sovereign debt, particularly just before a default, the act of default can trigger a banking crisis and therefore an economic crisis. Pension funds and insurance companies would also suffer.

Hyperinflation

What is this extreme risk?

In economics, hyperinflation is inflation that is very high or 'out of control', a condition in which prices increase rapidly as money loses its value. Definitions used by the media vary from a cumulative inflation rate over three years approaching 100 per cent to 'inflation exceeding 50 per cent a month'. As a rule of thumb, hyperinflation is often reported for short intervals, often per month.

Although there is debate about the root causes of hyperinflation, it becomes visible when there is an unchecked increase in the money supply, usually accompanied by a widespread unwillingness to hold the money for more than the time needed to trade it for something tangible to avoid further loss.

What are the consequences?

Hyperinflation wipes out the purchasing power of savings, provokes extreme consumption and hoarding of real assets, causes the monetary base to flee the country, and investment ceases. Historically, there have been numerous episodes of hyperinflation in various countries, followed by a return to 'hard money' (some form of non-devaluing medium of exchange).

Hyperinflation is often associated with wars (or their aftermath), economic depressions and political or social upheavals.

The general population prefers to keep its wealth in non-monetary assets or in a relatively stable foreign currency. Amounts of local currency held are immediately invested to maintain purchasing power. Prices may be quoted in a foreign currency.

End of fiat money

What is this extreme risk?

This risk relates to the return to a gold standard where the paper notes governments issue are freely convertible to preset, fixed quantities of gold (or other physical commodities). From a historical point of view, a repeated shifting between fiat and gold standards is normal. (The United States has repeatedly shifted between a fiat and gold standard over the past 200 years.)

We do not envisage a return to a gold standard in the near future. The escalating money creation around the globe is currently working fairly effectively to prevent another depression-like scenario. All of these efforts would become impossible under a gold standard structure. However, should these efforts result in rising inflation, then the return to a gold standard would have a higher probability in future.

What are the consequences?

As economic activity varies over time, the money supply should also be varying over time. Under a gold standard, however, the money supply is solely linked to gold production. Central banks have little discretion to protect the economy from either a monetary shock (a big discovery of gold, causing inflation) or a real shock. Therefore, goods prices are likely to be highly unstable in the short term despite being relatively stable in the long run. If every country adopted a gold standard, exchange rates would become effectively fixed, meaning that goods prices would have to adjust to changing circumstances in countries. Greater economic volatility would tend to raise risk premia, reducing the return on many assets.

Political and other

Protectionism

What is this extreme risk?

Protectionism is the policy of restricting trade with the aim of 'protecting' businesses and workers in the domestic economy from the full force of external competition. Protectionism is usually implemented through tariffs or quotas, although there are various other possible methods such as legislation (for example, specifying particular environmental or ethical standards), subsidies and exchange rate manipulation.

The present concern is that short-term political necessity (saving votes) can override long-term economic logic. The base case is protectionism at the margin. The extreme risk is a populist backlash against free trade.

What are the consequences?

Protectionism tends to harm the people it is intended to help. This follows from the principle of comparative advantage, under which countries should specialise in producing certain goods or services. Using protectionism to interrupt this process of specialisation imposes inefficiency (cost) on the economy pursuing protectionism, thereby limiting employment and economic growth.

Soberingly, protectionism has also been accused of being one of the major causes of war. Mercantilist European countries were often at war in the 17th and 18th centuries; the American Revolution was primarily due to British tariffs and taxes; and the two World Wars followed periods of protective policies.

Political crisis

What is this extreme risk?

As part of the global financial crisis and economic consequences, we have seen the rise of 'angry citizens'. The social anger in the best and most likely case will be vented through the ballot box. For example, in the elections for the European parliament in June 2009, UK voters elected two candidates from a fascist party – the first seats ever won by that party.

The extreme risk for democracies is that the level of anger overwhelms 'reason', giving significant power to a protectionist political party. For non-democracies, the risk is a venting of the anger in a more violent manner.

What are the consequences?

The investment implications would likely range from insignificant to mildly negative for asset returns, depending on the extent of the 'revolt'. Serious negative implications would be contingent on the new political power becoming entrenched, triggering other risks considered in this paper.

Disunity in Europe

What is this extreme risk?

The current global economic slowdown has raised tensions between euro member countries – principally between those with current account deficits which would prefer low interest rates and a lower euro, and the rest. The extent of devaluation required to assist the deficit countries would risk causing very high inflation in Germany – not politically feasible. The prospect of permanent large fiscal transfers from the surplus countries is also likely to be politically infeasible. It leaves a break-up of the euro as an extreme risk.

What are the consequences?

Leaving the euro would be painful and would entail losses for someone. As that 'someone' could/would include foreigners, perhaps withdrawing from the euro would be preferable to internal devaluation, where the domestic economy takes all the pain?

We believe that the Vienna Convention on the Law of Treaties allows a withdrawing country to redenominate all internal debt and all sovereign debt (including sovereign debt held by foreigners) in the new domestic currency. This would impose losses on foreign lenders. Private debt held by foreigners would be more difficult and probably decided by long drawn-out legal cases.

The end of capitalism

What is this extreme risk?

Capitalism's basic premise is that the pursuit of self-interest and the right to own private property are morally defensible and legally legitimate. In a pure capitalist economy, the market drives the allocation of resources and any economic decisions.

In our view, the most likely scenario is moving along from one end of a spectrum where market is king (minimum regulation) towards the other end, where we could see more onerous regulations and government intervention in, and control of, the economy. The extreme risk, however, is the demise of the capitalist system and the end of the market as the primary means of resource allocation.

What are the consequences?

The economy would be likely to run a higher risk of failure and economic growth would be sluggish in the long run due to lower productivity. Centrally controlled economies tend to be characterised by shortages, which are inherently inflationary. Private investment activities would collapse or even be terminated. The end of capitalism is simply the ultimate extreme risk. The economy is likely to be associated with extreme uncertainty and a large amount of wealth destruction during the transition period. On contemplating the end of capitalism, investors should probably worry more about the return 'of' their investments than the return 'on' their investments.

Climate change

What is this extreme risk?

The extreme risk is that climate change is real and happens much faster than anyone expects (or, at least, faster than anyone is prepared for).

While we discuss in other papers the possible investment opportunities that may arise, for current purposes the major implication is a diversion of capital from economically productive use (offering attractive returns) to mitigating the effects of climate change.

What are the consequences?

There is very little agreement on the consequences of climate change and it is possible that there would be benefits for some countries. In the context of this paper however we suggest the following potential negative consequences:

- a rise in sea levels, flooding low lying land (often agricultural) and causing storm damage to coastal cities
- reduced availability of drinking water, as glaciers disappear and low lying aquifers become salinated
- reduced agricultural output, due to land loss and salination
- a danger of increased conflict within and between nations over access to food and water.

Killer pandemic

What is this extreme risk?

The current H1N1 virus ('swine flu') was given pandemic status by the World Health Organisation. The risk we consider is a virus with similar contagion but much higher death rates. A major pandemic would infect a larger proportion of the population than typical flu (25-50 per cent rather than 5-15 per cent) and have a death rate that would be a multiple higher (normal flu kills around 0.1-0.3 per cent of those infected). A further difference with a killer pandemic is that it tends to kill those in prime health (ages 20-40), due to an excessively efficient immune system response (normal flu tends to kill the old, the infirm and the very young).

What are the consequences?

Assuming a significant proportion of the younger workforce died, output and therefore consumption would fall (GDP); businesses would be left with redundant capacity; government tax receipts would fall (possibly much faster than welfare expenditure). Equity returns would suffer from both capital destruction (redundant capacity) and lower earnings; corporate bond defaults would be likely to rise; sovereign yields could rise to reflect weaker government finances.

War

What is this extreme risk?

Armed conflict on a small scale is common and its economic impact is limited to the countries involved. The extreme risk is a major war that involves several major economies for a prolonged period.

The history of war is an inseparable part of human history and major wars can have catastrophic impacts on societies and economies. World War II ranks as history's worst disaster by death toll, with estimated lives lost between 60 and 72 million.

The invention of nuclear and biological weapons also raises the possibility that a future major war could put much of the human race at risk.

What are the consequences?

The major consequence of war is the destruction of capital – both physical capital as munitions explode and damage existing infrastructure, and human capital which, at best, is diverted from productive employment for a number of years.

The worldwide financial cost of World War II is estimated at about one trillion 1944 US dollars, making it the most costly war in capital as well as lives.

Similar to a killer pandemic, major war tends to kill those in prime ages (predominantly males), which leaves a (much) reduced younger workforce base and in turn reduces economic output and consumption.