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Balance of Payments -and Power- Crises

Model the world to model the economy

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Contents

- This report argues DSGE economic models fail to capture our now geopolitical world
- Such models assume shocks, such as higher import prices flowing to the balance of payments, are resolved by reallocating labour and capital, currency depreciation, and higher net exports, so returning GDP growth to its long-run trend
- We propose an adapted economic model that assumes: no guarantee of key input supply; or markets for new exports; or rapid labour rebalancing; or open-ended fiscal and monetary support
- This alternative approach results in large-scale *structural* deterioration in economic and market performance, matching the *structural* rise in geopolitical tensions
- We model two scenarios: 1) governments extend current energy support measures to 2027; and 2) a part of the industrial base is eroded by the crisis. Results are relatively benign for the first, but the second shows UK and Eurozone GDP respectively 7.2% and 7.4% smaller by 2027, unemployment rising by around 4 percentage points, and a large impact on both inflation and the exchange rate. This mirrors the experience of some emerging markets (EM) rather than developed markets (DM)
- In short, we believe our geopolitical world implies real 'DM > EM' risks

Introduction: Geopolitics matters

This 'thought piece' report argues standard economic modelling fails to capture how a 'geopolitical' world works while looking at three conflated crises: 1) Europe's energy crisis; 2) a potential European 'twin deficits' balance of payments crisis; and 3) the balance of geopolitical *power* crisis behind them both.

Such an assumption seems obscure but has enormous implications for macroeconomic and financial forecasts. Assuming a geopolitical world means a *structural* balance of power crisis, leading to *structural* commodity-driven balance of payments crises, then results in *structural* economic and market outcomes entirely different from those presented by cyclical 'apolitical' mean-reverting DSGE models.

We adapt an alternative model that assumes the risk of higher input costs, lower export opportunities, and of balance of payments crises with less space for fiscal and monetary policy easing: this results not in economic rebalancing, but in *snowballing deindustrialisation* and a structural deterioration of developed market international competitiveness and macroeconomic and market stability.

Specifically, our modelling approach finds significantly lower forecasts for the UK and Eurozone trade balance, GDP growth, and exchange rate, with higher inflation, out to 2027.

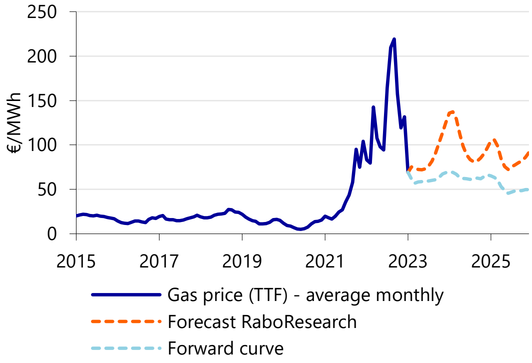
(Our model accounting for this can be found in the Appendix A.)

Energy crisis? What energy crisis?

Gas price dropped significantly over warm European winter

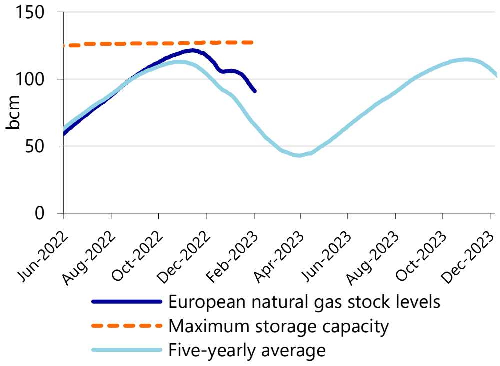
The European benchmark gas price currently stands at a fraction of the historic highs recorded in 2022 (Figure 1). Since mid-December, prices have collapsed due to high winter temperatures in Europe, and the depletion of gas from storage has slowed significantly, implying Europe might head into spring with significant amounts 'in the tank' (Figure 2). Market sentiment has therefore taken a turn, and gas forward contracts for Winter 2024 and 2025 are priced at 50-70 euros (MWh) vs. 75-100 euros for that tenor during autumn 2022. However, we do not think the EU or the UK are out of the woods on the energy front.

Figure 1: Energy prices to remain higher



Source: Macrobond, Bloomberg

Figure 2: Gas storage well above normal levels



Source: Macrobond

But Europe is definitely not out of the woods

Gas at 50-70 euro/MWh is more than double the average of the last few decades, pushing up production costs for all energy-intensive industries. Before the war in Ukraine, roughly 40% of Europe's natural gas imports came from Russia. Russian pipeline gas is now flowing to Europe at only a fraction what it was, meaning pipeline gas has to be replaced by much more expensive liquefied natural gas (LNG) imports from either Qatar, the US, or somewhere else. Notably, LNG production costs currently lie somewhere between 27-50 dollars/MWh hour (see Figure 3), with shipping costs being the most uncertain factor.

As such, it is hard to imagine European gas prices dropping to pre-war levels again unless the *geopolitics* of the matter change.

Figure 3: Production costs of LNG ranges 27-50 dollars/MWh

Upstream + pipeline	Liquefaction	Shipping	Regasification
$9.9 per MWh	$7.5 per MWh	$3.5 - $27 per MWh	$6.8 per MWh

Source: RaboResearch

Indeed, as long as Europe fails to safeguard its energy supply, it is susceptible to disruptions in the energy supply chain, be it either geopolitical or physical in nature. Each disruptive stone dropped into the pond will push prices upwards; and higher volatility makes it more difficult for firms to build a stable business base in Europe. In this sense, we already see some anecdotal evidence of the negative effects:

- Many firms are unable to fully pass on higher energy costs to consumers, crushing their profit margins or forcing losses, meaning less investment and a weaker competitive position;

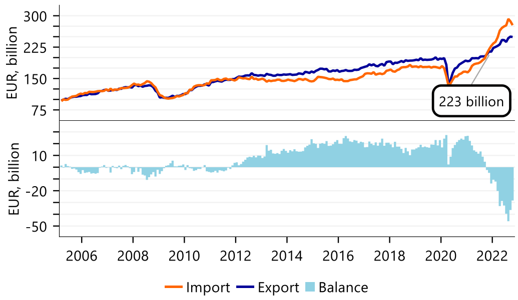
- Industrial production reacts aggressively to higher energy prices. When prices skyrocketed in 22H2, close to 10% of Europe's crude steel capacity was idled. Eurometaux says all of the EU's zinc smelters have had to curtail or even completely halt operation, with 50% of primary aluminium production also shut down, 27% of silicon and ferroalloy output, and 40% of furnaces. This also had an impact on the glass, ceramics, packaging, and chemicals sector. The European fertilizer sector also took 70% of capacity offline.
- EU firms are looking at or pledging major new investments in either the US or Asia, where energy is cheaper (e.g., BASF's new $10bn facility in China). Moreover, foreign capital invested in Europe is acting similarly: Dow Chemicals is to downsize most in Europe.
- In addition, the US has further strengthened its appeal for businesses with the passage of the CHIPS Act and Inflation Reduction Act (IRA), with huge tax subsidies. The EU approved EUR540bn of emergency state aid and there are now European calls for an "unprecedented" package of EU subsidies to try to match the IRA.

Balance of payments crisis

The Terrible Twins

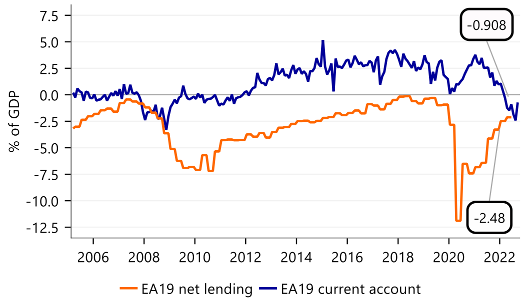
Because the Eurozone is a large energy importer, its trade and current accounts both moved into deficit as gas prices rose, something not seen on this scale since the Global Financial Crisis (see Figure 4). Eurozone fiscal balances have also swung into deep deficit due to the cost of energy subsidies provided to try to reduce the economic pain (see Figure 5): more is to follow as Europe tries to counter the US IRA with its own tax credits/subsidies). The UK is ahead in both deficit dynamics, and is less well placed to offer fiscal incentives to firms to base production there.

Figure 4: Trade balance collapsed



Source: Macrobond, Eurostat

Figure 5: Twin deficits are already here



Source: Macrobond, Eurostat

Crucially, an external deficit now places a limit on the scale of fiscal deficits Europe and the UK are able to run without: raising interest rates more; seeing bond yields rise; or seeing their currency drop (as we posited in our work on MMT). None of these are welcome: higher rates threaten economic stability; so do higher bond yields, especially if between Eurozone members; while a weaker currency feeds inflation. As a key example, the BoE refused to buy Gilts in the 2022 Truss Crisis prompted by floated tax cuts; yet Sterling was pushed lower until the government U-turned to tighter fiscal policy *into a recession*, something traditionally seen in EM, not DM.[1]

As such, looser fiscal policy is risky. However, dropping fiscal support for businesses would accelerate industrial recession and the structural shift of firms to the US and Asia, widening the external deficit even further, and perhaps permanently. In short, there are no good options.

[1] The ECB's Transmission Protection Instrument so far remains unused, and could supress peripheral yields via bond purchases; but it would surely push the Euro much lower in the process. Although the Euro has a larger global SWIFT share than Sterling, almost all of this reflects intra-Eurozone economic activity: external to Europe, where funds have to be found to cover any external deficit, the Euro has a minimal role. It may even need Fed swap lines, like an EM. Hence it is also vulnerable – though we believe its larger scale makes it less so than Sterling.

Balance of power crisis… cutting DSGE's power

We need to do more zero-sum sums

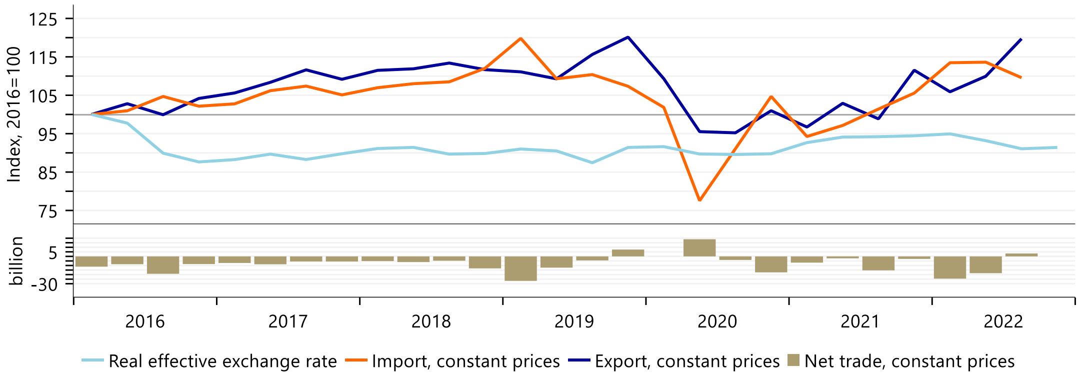
Warmer weather is literally seeing things look sunnier in Europe than a few months ago. However, luck and/or climate crisis is hardly the basis for sound policy - or economic modelling.

Traditional DSGE economic models assume there is an easy way out of the mess described above: *a lower exchange rate results in exports picking up relative to imports, allowing a differently-structured economy to return back to near-trend growth*. In short, the tight European or UK labour market is presumed to result in workers simply shifting from the shrinking industrial sector to the growing services and export sectors, so both employment and the economy rebalance.

Under the recent crisis, however, there is reason to question those assumptions. Importantly, DSGE models overlook the negative impact that a sudden, large-scale *structural* erosion of the manufacturing base have on the balance of payments and macro stability. This is where we need to turn to the *balance of power* behind the balance of payments: is it cyclical, or permanently geopolitical? Can the economy push back against it in that dimension, if so?

There are clear examples of this not happening: self-inflicted, yes, but the post-Brexit UK has failed to see any gain in its net export performance despite a far lower nominal and real exchange-rate post-Brexit (See Figure 6). *We believe the same effect can be felt by other economies due to broader geopolitical developments:*

Figure 6: A weaker exchange rate has not led to an improvement of UK net trade



Source: Macrobond, ONS

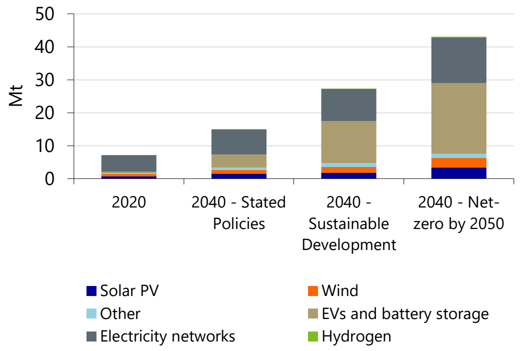
There is no guarantee of security of supply of commodity inputs. In 2020, the European Commission examined a list of 5,200 products and identified 137 for which Europe is dependent on foreign supply. For 34, substitution possibilities are very limited, including products like pharmaceutical ingredients, raw materials (indium, gallium, silicon metals, rare earth metals, and platinum-group metals), but also intermediates, such as batteries and semi-conductors, with the lion's share of these key imports being shipped from Asia.

Energy is also an obvious example, and although European supply is no longer reliant on Russia, it is instead centred on the US and Qatar. A green transition is no easier, as global demand for key minerals is soaring (Figure 7), yet Europe may fail to secure adequate supplies given China's de facto control over lithium and cobalt supply chains, as well as rare earth minerals (Figure 8). Indonesia is also suggesting the formation of a producers' cartel for nickel; and the Philippines said that it may tax nickel exports to encourage value-added within its economy.

The EU's 2022 Critical Raw Materials Act has been the response so far, but it is unclear how it will help establish adequate commodity supply chains: the UK has no response at all to date.

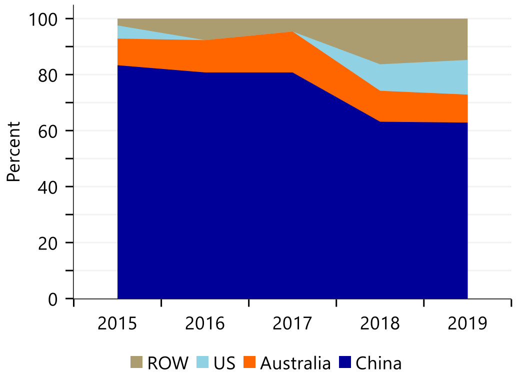
By contrast, DGSE models have an underlying open-world economy assumption that supplies of commodities are freely available and never weaponised, as even food was for a time in 2022 (and may be again going forwards).

Figure 7: Mineral demand set to explode



Source: Macrobond, IEA

Figure 8: China produces most rare earth metals



Source: USGS

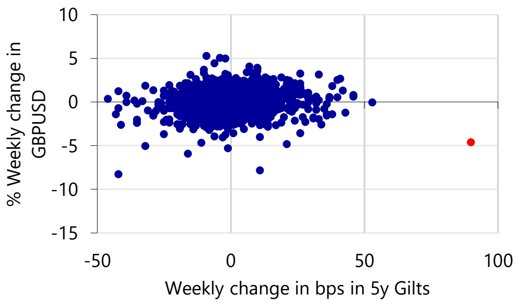
There is no guarantee of global market demand for new exports. We are entering a new age of mercantilism and protectionism, with the US and China both subsidising new industrial production and domestic supply chains, creating agglomeration effects: the EU and the UK are both struggling for an adequate response within the twin deficit constraints already described. Post-Covid and post-Ukraine, many economies are looking to increase resilience – which means more production closer to home. We are also seeing growing restrictions on the exports of technology. In short: this is a geopolitical world economy.

By contrast, DSGE models have an underlying open-world economy assumption that a drop in domestic production means a lower exchange rate, *temporary* higher inflation, and then a surge in net exports that allows growth to return to trend. Those mechanics no longer hold true under mercantilism.

There is far less fiscal and monetary policy room than seen from 2019-2021. It does not take much creativity to come up with a recent instance when we could see how a lack of confidence in a DM by financial markets contributed to volatility in foreign exchange markets. Investors lost faith and immediately withdrew their money from the UK after PM Truss presented her £45bn fiscal package aimed at boosting the UK economy’s growth rate. This caused a depreciation of sterling of roughly 5% in a week, and rates skyrocketed at the same time, shattering the conventional economic correlation between rates and FX for the DM UK (Figures 9 and 10).

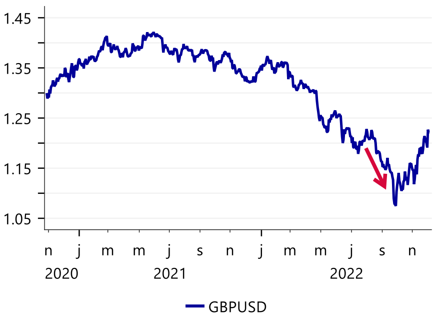
By contrast, DSGE models think there are few effective restraints on fiscal and monetary policy.

Figure 9: Correlations break down under stress



Note: Red dot is the week where investors lost faith in Truss
Source: Macrobond

Figure 10: Spot the Truss fiscal plan launch?



Source: Macrobond

There is less labour market flexibility than assumed. The scale and speed of the 2022 commodity supply-side shock makes labour rebalancing hard: the experience of past structural labour-market transitions shows regional pockets of high unemployment can easily occur: technology like working from home may help to some extent, but is far from guaranteed.

By contrast, DSGE models assume rebalancing will occur smoothly and rapidly.

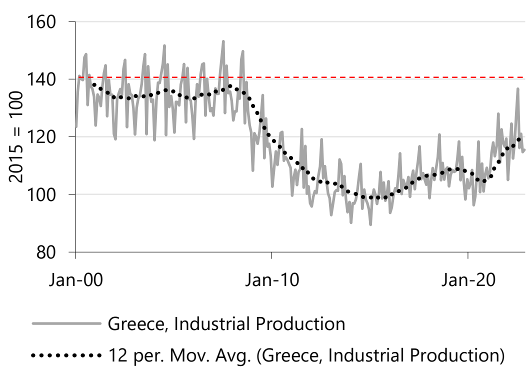
The painful DM > EM truth

If geopolitics is structural, economies who suffer resulting higher import prices alongside shifts to new industrial sectors being constrained by vast capital requirements, protectionism, and subsidised imports, then instead of rebalancing we could see **a *structural de-industrialization***: lower employment; lower valued-added; lower investment; no/lower growth in exports; lower trend GDP growth; *structural* balance of payments deficits; a *structural* trend lower in the exchange rate; *higher* rates of inflation; *tighter* fiscal and monetary policy; lower asset markets and their wealth effect; and perhaps even a decline in population growth and/or emigration of the young and talented, reducing human capital and leaving debts to be serviced by an inverted demographic pyramid.

Greece's hollowing out within the Eurozone post-2000 (Figure 11) or Argentina's repeated set-backs under varying exchange-rate regimes (Figure 12) are the *very* worst-case exemplars for a DM experiencing a geopolitical balance of power like an EM, should it fail to react appropriately. **We summarise these risks with the moniker: 'DM > EM'**

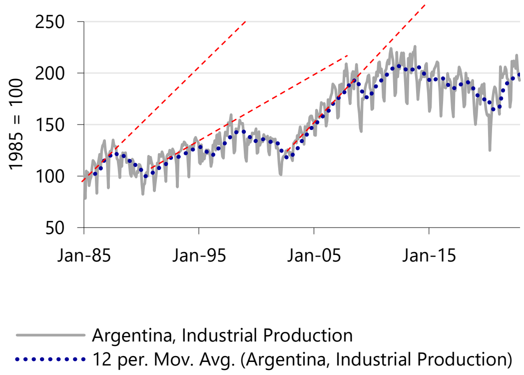
Imbalance of Power

Figure 11: Not so much grease in Greece



Source: Macrobond

Figure 12: Always coming up for Buenos Aires



Source: Macrobond

If the global backdrop remains structurally geopolitical, do the UK and the Eurozone have the ability to push back within that dimension? Arguably they do not.

The UK is too small an economy to boss markets, as recently made clear; it lacks key resources; it has cut itself loose from its EU moorings just as global blocs are forming and economies of scale matter most; and it is suffering evident policy drift. Even its vaunted military is a shadow of what it once was, with a US general recently stating it is "no longer a top-level force": decades of under-investment have left the UK with aircraft carrier capacity, but unable to project even a small field army abroad without years of greatly increased budgets - in an age of austerity when fiscal deficits are a problem to sustain. The UK defence industry's supply chains have been largely dismantled and need to be rebuilt from scratch - at a time of rising input costs; or weaponry needs to be imported, further worsening the balance of payments.

For the Eurozone things are far worse. It has a larger scale, but less unity, as well as the lack of key resources: the slow and awkward response to higher energy prices, Russia, China, and the US IRA all underline these structural problems. France aside, its defence base is weak, with no common military procurement: only major reforms and decades of investment would reverse this - at a time of potential twin deficit crises. Meanwhile, the US is providing LNG and contributing the most arms to the Ukraine War effort. European "strategic autonomy" this is *not*.

Indeed, while Europe and the UK have been rudely awakened from soft-power free-trade and 'Global Britain' daydreams, China and the US are pursuing strategies to guarantee supply-chain resilience, as well as technological and military realpolitik power. Neither Europe nor the UK are well placed to compete on these terms ahead – or at least not solo.

Where DSGE Models Go Wrong

DSGE (Dynamic Stochastic General Equilibrium) macroeconomic models are widely used by economists for policy analysis and forecasting. Many central banks still use DGSE models as tools in their decision-making process.

The seminal paper by Nobel Prize winners Kydland and Prescott (1982) is seen as the start of dynamic general equilibrium modelling. These first 'real business cycle' models soon lost their appeal, however, over their assumption of frictionless labour markets. Later New Keynesian models factored in sticky wages and prices, and the role of monetary policy. Even so, DSGE methodology has been heavily criticized since such models did not predict the GFC of 2008, nor the post-2008 vulnerability of the global economy. Eichenbaum, Christiano and Trabandt (2018) argue DSGE models have evolved since the 2008 failure, incorporating financial frictions, borrowing constraints for consumers and nonlinearities in economic relationships. However, criticism runs much deeper.

Heterodox economic schools, such as the post-Keynesians, underline DSGE models are inherently unable to capture any large exogenous shocks because they ignore political economy (i.e., labour vs. capital), and the role of credit and private debt. Instead, they 'apolitically' assume a credit-free economy, which adjusts to any new equilibrium based on rational, self-interested, long-term economic decisions made by perfectly informed, apolitical households and firms.

Unfortunately, (political-) economic reality is far from this mathematical theory. The pre-2008 experience shows credit matters hugely; the post-2008 experience shows labour vs. capital also does; 2022 now underlines geopolitics does too. Moreover, shocks can break stable historical relationships, and there is ample evidence that individuals do not maximize "economic utility", but are rather driven by fear, greed, and other rational inconsistencies: behavioural economics analyses this, but that is left out of the DSGE.

This critique is even mentioned by Stiglitz (2018) who argues, "*Large DSGE models that account for some of the more realistic features of the macroeconomy are typically 'solved' only for linear approximations and small shocks - precluding the big shocks that take us far away from the domain over which the linear approximation has validity.*" For instance, DSGE models imply we assume no permanent scarring to the Eurozone economy from the energy crisis, and that higher exports allow all economies to rebalance after such shocks, rather than seeing lower trend GDP growth rates.

What we model instead

Patching the patchy general equilibrium model

We now elaborate on the alternative framework we use to analyse the economic impact of an imbalance of geopolitical power resulting in a structural balance of payment crisis, as well as the various implications and permutations involved.

First, we have no illusions that we have come up with a completely new economic model to replace the macro-econometric policy model RaboResearch uses for economic scenario analysis: NiGEM. This is a sophisticated model academics and economists have been working on for decades. However, although NiGEM is not a DSGE model in the strictest sense, it also suffers from the same issues, rendering it unfit for the purposes of this report. Therefore, we have developed a side model containing a simple set of equations of variables of interest, and solve them integrally in one system (see Figure 13) to produce intertemporal outcomes of certain variables, such as trade, wages, and the exchange rate.

That doesn't mean we throw away decades of macroeconomic modelling work. If fact we build upon these models, with a consequence that some of the flaws of the DSGE models are also present in our model, like linear equations, absence of a credit channel and some reversion-to-the-mean mechanics. However, we focus on a few shortcomings of traditional models and try to solve these.

One issue we try to solve is that in DSGE models a current account shock with a depreciated currency leads to more favourable terms of trade with higher exports as a consequence. This largely compensates for the initial shock and helps the economy to recover fast and (almost) fully. In previous sections we have shown this is not realistic in the scenarios we want to analyse. In these situations it is more realistic that a return to the old growth path is out of sight, or at least will take much, much longer given the structural changes that take place.

Another issue we try to solve is the fast recovery of labour markets in traditional models. These models don't take into account the difficulty of labour market adjustments in case of structural changes in the economy. Skills mismatch between supply and demand is not solved within a few years for example.

To solve these issues we use an agnostic model useful under disequilibrium conditions, as it does not impose any ex ante restrictions on certain relationships. To be more specific, our model does not adopt an error correction mechanism for certain variables, pushing them back towards long-term trends, force the domestic labour markets to clear based on predefined wage and price dynamics, or expect exports and imports to swiftly rebalance based on a change in relative import and export prices. Next, we feed some of these exogenous calculated variables to NiGEM to gauge the impact on more complicated relationships, such as GDP and unemployment. In this fashion we adopt the way of working advocated by Blanchard (2016): *"I strongly believe that ad hoc macro models […] have an important role to play in relation to DSGE models. They can be useful upstream, before DSGE modelling, as a first cut to think about the effects of a particular distortion or a particular policy."*

By using this eclectic approach we aim to obviate the critique on general equilibrium models by e.g. Stiglitz (2018): *"The criticism of DSGE is thus not that it involves simplification: all models do. It is that it has made the wrong modelling choices, choosing complexity in areas where the core story of macroeconomic fluctuations could be told using simpler hypotheses, but simplifying in areas where much of the macroeconomic action takes place."*

Of course, our approach is far from perfect, but we think it is a step in the right direction.

An important caveat is that the relationships we estimate are based on historical data, while during crisis periods there may be a shift in the probability distribution of variables, critique that also has been brought to the fore with respect to DSGE models (see Mizon and Henry, 2014).

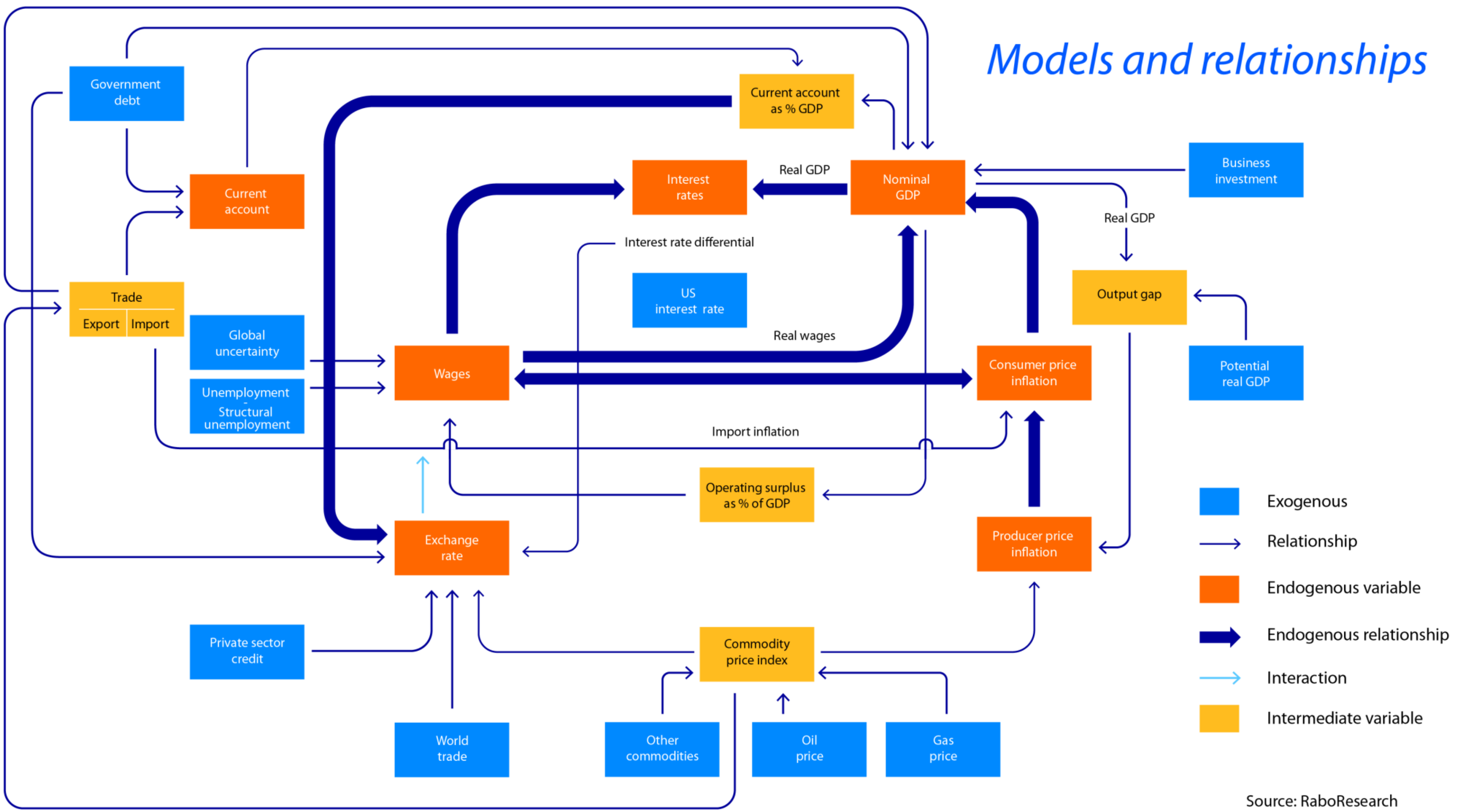
For example, the Eurozone has never encountered a balance of payment crisis in its short history (although individual member states have). Therefore, our side model is unlikely to pick up any of those dynamics in the data.

For simplicity, we mirror our empirical outcomes for Europe to that of the UK, a country with a richer history of balance of payment crises, and apply some of the empirical elasticities for the UK to the EZ. This is far from ideal, but at least takes into account that an economy could behave differently in a new volatile and uncertain situation compared to the more stable one represented by the empirical data.

A second caveat is that we still have to rely on NiGEM to gauge the impact on more complicated relationships, which again forces us to use general equilibrium modelling to some extent.

It would be interesting to use other structural models that are able to deal with prolonged spells of economic weakness and financial instability (e.g. Keen, 2013 and here). The downside of this approach, however, is that we would still have to feed the model parameters we do not actually know, as we lack the empirical underpinnings.

Figure 13: A satellite model of the economy



Source: RaboResearch

DM > EM dynamics for the UK and Eurozone

We now apply 'DM > EM' modelling to the UK and the Eurozone. We first assume the UK and Eurozone face more expensive energy going forward. As the next step, we run two scenarios:

Scenario 1: Subsidies to 2027

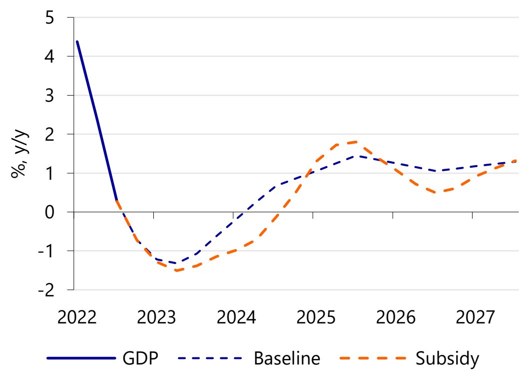
Here we assume the UK and each Eurozone member state finance a sizable portion of the energy price shock (and/or counter-US IRA action) by extending the current energy subsidies (or new counter-IRA subsidies) through the year 2027. (Please refer to Appendix B for specific calculations on the greater import volumes and increased nominal government debt involved.)

The cost of extending the subsidies over and above current plans would, energy price depending, be approximately £85bn for the UK, with the majority of the spending concentrated in the first few years. After a while the forward curve for gas and electricity dips below the level at which the government intends to subsidize it. The UK's public debt ratio would be roughly 4 percentage points higher in this subsidy scenario.

Governments in the Eurozone that subsidize energy prices incur high costs too. For instance, Germany has promised a €200 billion package to help consumers and businesses in 2023 and 2024. However, not every government is in a position to offer such big subsidies, and a race for subsidies within the Eurozone doesn't seem very enticing because it could endanger the single market's level playing field (and counter-IRA subsidies would of course do the same). We arrive at a total cost of €700 billion for the Eurozone using the same methods we used for the UK (1% of GDP on average).This would also result in a 4-percentage point increase in the Eurozone's overall government debt ratio.

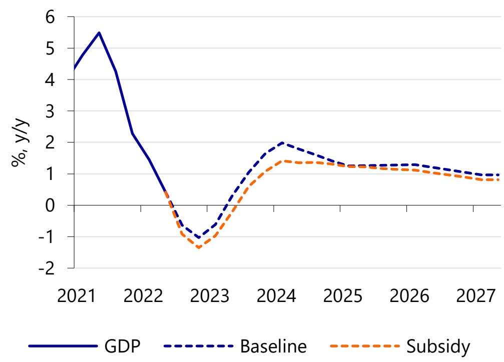
The impact of our subsidy scenario is modest when compared to economic crises like the Global Financial Crisis (GFC) of 2008-09. In fact it's more similar to the Dotcom crisis in the early 2000s: not an existential crisis, but still a painful change the structure of the economy to some degree.

Figure 14: GDP growth under pressure in the UK



Source: RaboResearch

Figure 15: And also in the Eurozone



Source: RaboResearch

GDP and the labour market would be negatively affected, with the UK and Eurozone economies projected to be 1.4% smaller at the end of the scenario horizon vs. baseline (Figure 14 and 15) and unemployment rates rising by 0.2 percentage points in the UK and 0.4 percentage points in the Eurozone.

Notably, in this scenario Sterling will weaken by around 9% vs. our baseline, while the Euro will weaken by around 6%; higher imported inflation as a result would put upwards pressure on the BOE and the ECB alongside downward pressure on real wages.

Scenario 2: De-industrialization scenario

In the second scenario we assume that a part of the industrial base of the UK and the Eurozone will still disappear as a result of the energy crisis and/or as a result of a more favourable investment environment elsewhere - with no rebalancing. (Again, for the exact methodology, please refer to Appendix B).

We assume industrial production will fall by 10%. This has a marked impact on the UK trade balance. Lower production doesn't only result in lower exports, but also has an effect on imports: while companies would no longer need to import raw materials or intermediate goods, additional imports would have to make up for the loss of domestic production; given the higher value of finished products, the latter effect dominates overall.

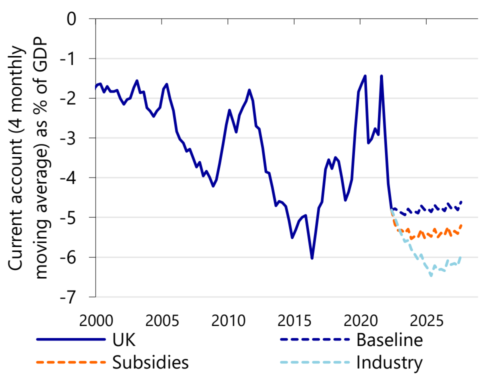
In the UK, a permanent 10% drop in industrial production will eventually add £80 billion to the annual trade deficit, or 3% of GDP. (For a more detailed explanation, see Appendix B.) De-industrialization and lower GDP growth is not just a British problem, however. The situation is considerably worse in several European countries given their relatively larger industrial sectors. There, we again assume a production slump of 10% and an eventual hit to the trade balance of approximately €700bn, or roughly 4.4% of GDP.

As anticipated, this scenario's impact is significantly greater than that of the first. The outcomes for a few key economic metrics are explained below.

Current account

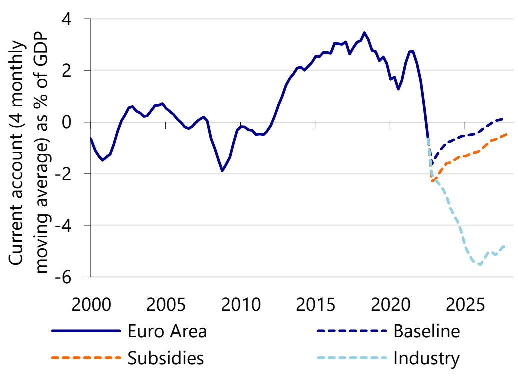
The UK current account deficit would widen sharply to level off at roughly 6% of GDP (Figure 16), which is comparable to the deficit just after the Brexit vote. However, this shock is mild compared to that in the Eurozone, where the current account drops by roughly 4% of GDP vs. baseline (Figure 17). Even worse than this shock is that the Eurozone current account surplus turns into a *structural* deficit, not a cyclical one.

Figure 16: A shocking decline in this scenario



Source: RaboResearch, ONS

Figure 17: ...but far worse in the Eurozone

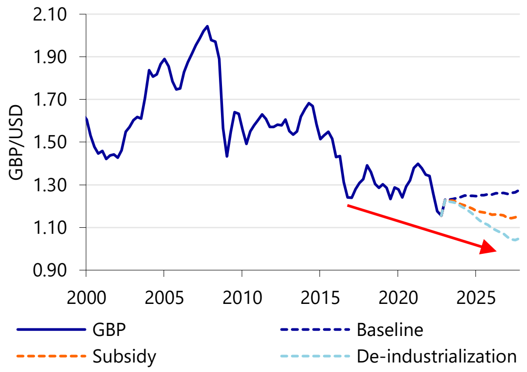


Source: RaboResearch, Macrobond

Exchange rate

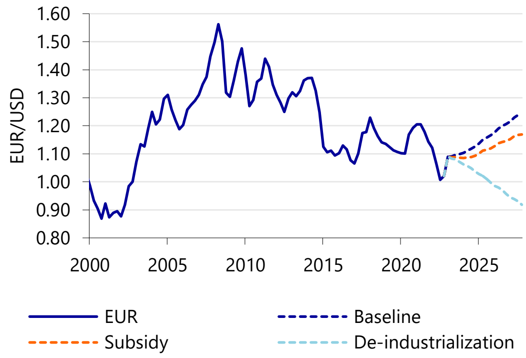
As may be expected, a structural deterioration of the current account affects the exchange rate, causing Sterling to devalue by almost 4% annually towards a level close to parity (Figure 18). Such a structural decline is admittedly a risk scenario, but given the track record and trend over the past years, is not completely unheard of.

Figure 18: Sterling would incur a hit



Source: RaboResearch, ONS

Figure 19: And the Euro is likely to take a beating



Source: RaboResearch, Macrobond

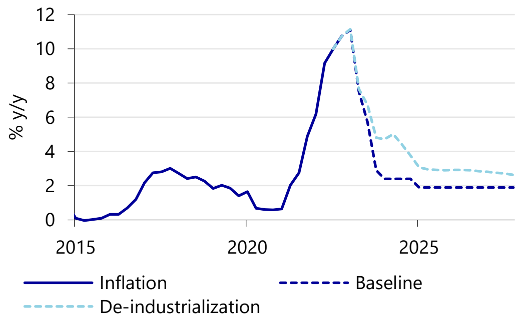
It is difficult to quantify the effects on the Euro given the lack of data, and we argue that the correlation between the current account and the exchange rate is likely to be weaker than for the UK, because of aforementioned reasons of relative scale: we assume that the FX effect of a weakening current account is roughly half of that in the UK. (Please see the other equations we estimated for this modelling exercise are empirically estimated for the Eurozone in Appendix A.)

The overall FX effect is still a lot stronger, however. Indeed, de-industrialization, which happens faster than in the UK, would have a significantly larger impact on the Eurozone's current account because a sizeable share of its industry is focused on *extra*-Eurozone exports. Indeed, under this scenario the Euro falls to around 0.90 to the US Dollar, or around a 17% decline (Figure 19).

Inflation and wage growth

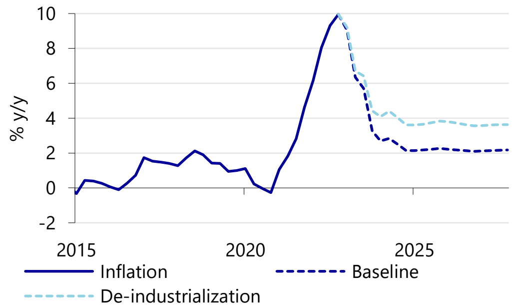
A weaker exchange rate put upward pressure on inflation. Our model results show inflation would remain well above the inflation targets of the BoE and ECB, and both the UK and the Eurozone would have to get used to inflation rates of 3-4% for years to come (Figures 20 and 21).

Figure 20: Inflation likely to settle at higher level



Source: RaboResearch

Figure 21: The same holds for the Eurozone



Source: RaboResearch

Higher inflation usually leads to higher nominal wages as workers demand a higher compensation to protect their purchasing power, but we do not expect wages to move in line with inflation in this scenario.

First, we expect GDP growth to collapse (more on that shortly) as the net trade position deteriorates sharply. This will have an impact on firm profitability and consequently leave very little leeway to increase wages.

Second, we expect wages will only rise moderately as a result of a composition effect. Until workers laid off as a result of de-industrialization find work in another sector, a higher unemployment rate will put a lid on wages; moreover, wages (and productivity) for these workers are likely to be lower in the services sector.

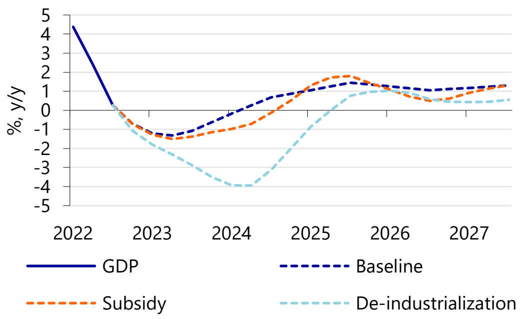
GDP and unemployment

Lower average productivity, lower purchasing power, and the effect on net trade will all weigh on economic growth in both the UK and Eurozone.

Notably, we project that the UK and Eurozone economies would be 7.2% to 7.4% smaller in 27Q4 compared to our baseline scenario, a substantial adverse impact. Indeed, for the Eurozone GDP growth over the period is rarely positive, and struggles to hit a 1% y-o-y threshold (Figures 22 and 23).

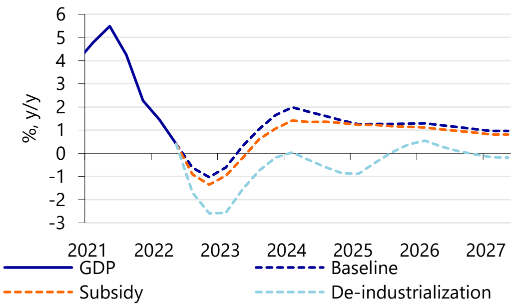
These figures underline the scale of the potential impact from de-industrialisation, even in an economy not widely considered as still being an industrial power like the UK. The economic impact is not limited to just a 10% shock in industrial production. The breakout box highlights the additional factors that worsen the economic damage.

Figure 22: GDP shock is much stronger this time



Source: RaboResearch

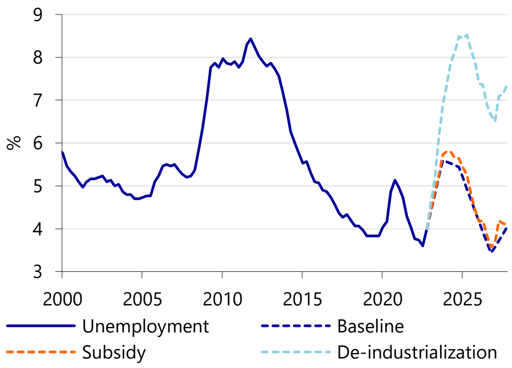
Figure 23: For the Eurozone, it's no different



Source: RaboResearch

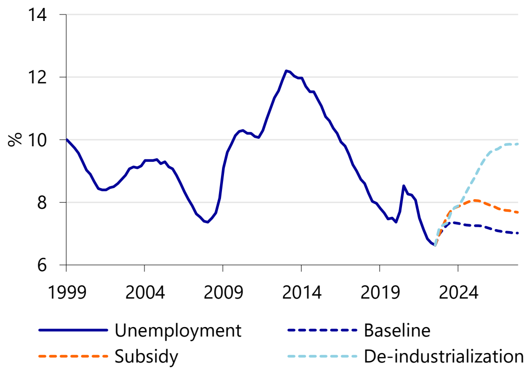
Lower growth rates will obviously have an impact on the labour market. While we might see some delay as a result of the current tightness there, the unemployment rate would eventually rise in this scenario, by 4 percentage points in the UK, before a slow recovery, and by 3.5 percentage points in the Eurozone, to a level of 10%. The risks would be to the upside, if anything, and would again be more structural than cyclical, suggesting permanent hysteresis effects, again undermining potential growth. (Figures 24 and 25.)

Figure 24: UK unemployment back to GFC levels



Source: RaboResearch

Figure 25: EZ unemployment rises by 3.5ppts too



Source: RaboResearch

Notably, all of this also fails to account for potential population outflows and declines in R&D budgets and related investment: again, this presents even greater downside risks within the 'DM > EM' envelope.

Why do we expect such a large economic shock?

The economic damage in this scenario is severe considering the relatively "moderate" shock of 10% to industrial production, which accounts for only a portion of the UK and Eurozone economies. However, such a large shock to GDP is due to a multitude of *second-order effects* that the DSGE model overlooks.

The most important is the impact of a lower currency on inflation via the import channel: prices increase, and if wages do not keep up, household purchasing power falls, placing a brake on economic growth. But it doesn't stop there. Falling consumer demand and higher prices have an impact on business investment too, since companies postpone or stop investing altogether.

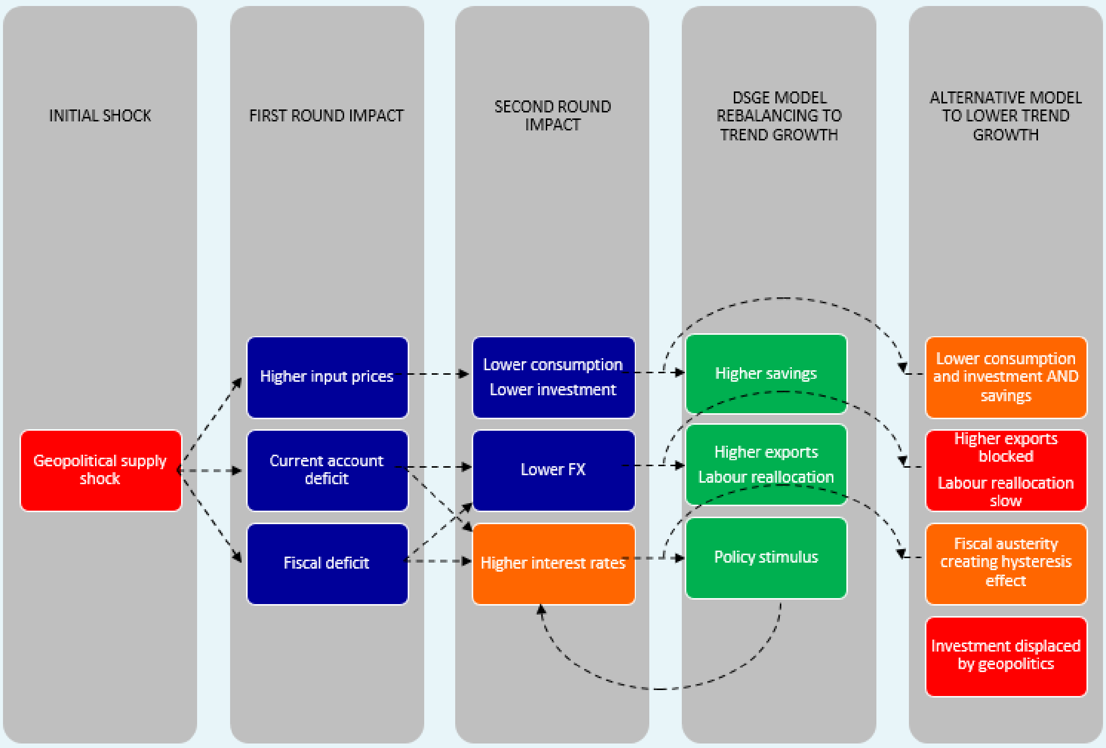
Alternatively, if wages do keep up with the higher price level, the profitability of firms falls, again with lower investment - and so lower short and medium term growth as a consequence: moreover, that implies higher inflation, and so a stronger interest rate response from the central bank, hitting growth.

Moreover, exporting ones way out via a lower exchange rate is also hampered by geopolitics in the form of protectionism closing new markets off, mercantilist subsidised imports replacing former domestic production, and other economies luring investment offshore.

The room for fiscal and monetary policy stimulus is additionally hampered by twin current account and fiscal deficits, which push the exchange rate down and either rates and/or bond yields up. Yet if austerity is embraced, ending energy subsidies, then inflation rises even higher, and/or GDP growth is hit even harder, with damaging long-run hysteresis effects.

Reduced labour productivity is another factor given industry’s is higher than in services: when workers are forced to find work in another sector, average productivity declines. A final related point we do not consider the effect of in our analysis is that as corporate and state investment diminishes, so does R&D spending, one of the engines of structural GDP growth (see: Productivity, R&D and Entrepreneurship, H. Erken, 2008).

Figure 26: An overview of the second order effects on economic growth



Source: RaboResearch

Conclusion: The crisis may just be starting

Despite the complex equations we have used, the key conclusion is quite simple – and shocking: ***despite a warm winter, Europe and the UK are far from out of the woods.***

If we assume the world is now *structurally* geopolitical, rather than Ukraine being a 'one-off', then we have to presume there is a *structural economic shift* where such shocks can be repeated. Indeed, we now see: no guarantee of supply of key inputs; no guarantee of new export markets; no guarantee of easy labour market or sectoral rebalancing from any downturn; and no guarantee of previous fiscal and monetary policy options still being available to pursue[2].

Neither the UK nor the Eurozone are well placed to thrive in such a hostile environment.

Traditional DSGE models are therefore wrong to still assume how the economy operates in present conditions, because they do not understand how the world it sits in has changed. Such models still tell us that this crisis is mostly over because they are mean-reverting and apolitical: yet the true crisis may just be beginning as we revert to meaner geopolitics and higher macro-instability.

Our alternative modelling approach without DSGE assumptions clearly shows a potentially huge negative impact on both the UK and the Eurozone, if so.

If the current energy shock --and US and Chinese industrial strategy-- is matched with extended UK and Eurozone fiscal subsidies, then our already weak economic and market baseline scenario largely holds unchanged. Even so, the UK and Eurozone economies are still 1.4% smaller in 2027 than they would have been, which is not insignificant.

Yet if a deliberate *geopolitical* energy shock, its knock-on to the balance of payments and fiscal deficits, market pushbacks restricting monetary and fiscal policy options, and *protectionism* that close off export options and weans investment to the US and China all translate into a process of deindustrialisation, then both the UK and Eurozone economies will suffer greatly. Worryingly, anecdotal evidence suggests this process may already be underway.

In such a scenario, we project the UK and Eurozone economies to be 7.2% and 7.4% smaller than our baseline projections by 2027, respectively, *with no sign that this will be reversed after that*. At the same time, inflation would be much higher, as would unemployment --pulling the BOE and ECB in different directions on rates-- while Sterling and Euro exchange rates would be far lower.

Overall, the transition would mean that even these two developed markets (DM) would look much more like emerging markets (EM).

As such, economists and market analysts should arguably pay much closer attention to the key question of whether we are in a geopolitical or an apolitical world economy, and adjust their models and forecasts appropriately.

Sometimes balance of payments crises are actually balance of power crises; and if that is the case, entirely new (political)-economic solutions are going to be required to resolve them.

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[2] Except for the US with thanks to the dollar as the global currency reserve: but even then, with some caveats. See our previous work on this area related to Modern Monetary Theory.

Appendix A: Balance of Power equations

In this Annex, we elaborate on the satellite model that RaboResearch has developed to capture EM dynamics under a supply-side shock. It contains of a simple set of equations, which is solved integrally in one system (also see Figure 13). The system produces intertemporal outcomes of certain economic variables, such as trade, wages and the exchange rate. The upside of this approach is that we use an agnostic model that is useful under disequilibrium conditions, as it does not impose any ex ante restrictions on certain relationships. Below we discuss each of the separate building blocks of the system.

Inflation

Our inflation equation is based on the model by Gordon (1997), who uses three basic determinants of the inflation rate: inertia, demand and supply:

$$\pi_t = \alpha \pi_{t-1} + \beta(D_t) + \gamma(Z_t) + \varepsilon_t \quad (1)$$

where π indicates inflation, *D* is a measure of demand (in our case *wages*) and *Z* denotes supply-side shocks, such as commodity price shocks or exchange rate movement. *t* is a time-specific index. McCarthy (2007) has reviewed the literature and empirically estimated the impact of exchange rate passthrough on consumer and producer prices. Ultimately, we arrive the following equation:

$$\Delta CPI_t = c + \alpha_1 \Delta\left(\frac{W_t}{H_t}\right) + \alpha_2(\Delta PPI_t \geq 4)(\Delta PPI_t) + \alpha_3(\Delta PPI_t < 4)(\Delta PPI_t)$$
$$+\alpha_4 \Delta M_t \cdot \Delta FX_t + \alpha_5 DUM_t^{GFC} + \varepsilon_t \quad (2)$$

where *CPI* is the consumer price index, Δ is the (y/y) percentual change of a variable, *c* is a constant term, *W* is compensation of employees, *H* the amount of hours worked, *FX* is the change of the exchange rate vis-à-vis the USD. This is interacted with the import volume (*M*) to account for import inflation that is not directly picked up by producer prices (*PPI*), and DUM^{GFC} is a dummy variable to account for the global financial crisis. Finally, ε is an idiosyncratic error term.

Producer prices are also endogenously estimated by:

$$\Delta(PPI_t) = \mathrm{c} + \alpha_6 \Delta(PPI_{t-1}) + \alpha_7 HWWI_t + \alpha_8\left(\frac{Y_t}{Y_t^*}\right) + \alpha_9\left(\frac{CA_t}{Y_t^N}\right) + \varepsilon_t \quad (3)$$

where we included a lagged dependent variable to capture stickiness in producer prices, related to retail-manufacturer interactions and long-term contracts as well as coordination failure among price setters (see Nakamura and Steinsson, 2013). *HWWI* is a commodity index. *Y*/*Y** is the output gap, which measures an economy's GDP (*Y*) in relation to potential production (*Y**).[3] An economy can temporarily operate above the potential level by asking people to work overtime or postponing capital maintenance. However, at some point the slack is gone and entrepreneurs in an overheated economy will raise their prices. A positive output gap is therefore inflationary, while a negative output puts downward pressure on prices.

CA is a four-quarterly moving average of the seasonally adjusted current account balance. If import prices (vis-à-vis export prices) are increasing fast, this consequently weighs on the current

[3] Potential production is the maximum sustainable production that an economy can handle, given the production structure, the use of production factors (raw materials, labour, capital), and the state of technology.

account and at the same time pushes up producer prices. CA thus captures dynamics[4] of relative international price levels associated with relative competitiveness and trade. The current account is especially important to pick up the impact on producer prices of more expensive imports other than commodities, e.g. intermediates or services, which are also prone to price rises in case of a commodity price shock (such as energy price shock), especially in terms of second or third order effects. Finally, we add a trend term (*T*).

Of course, inflation expectations play a major role in inflation dynamics of country (e.g. Friedman (1968)), which also plays a role in de the wage setting process (Blanchard en Katz (1999)). Although inflation expectations are taken into account in the official inflation modelling of RaboResearch, we abstract from these dynamics in this specific report, for sake of simplicity.

Commodity prices and the current account

For the modelling of the commodity price index and the current account we use these fairly straightforward equations:

$$\Delta(HWWI_t) = \mathrm{c} + \alpha_{10}\Delta HWWI_{t-1} + \alpha_{11}\Delta(Brent_t) + \alpha_{12}\Delta(Gas_t) + \varepsilon_t \qquad (4)$$

$$CA_t = c + \alpha_{13}D_t^N + \alpha_{14}(X_t^N - M_t^N) + \varepsilon_t \qquad (5)$$

The commodity index equation consists of oil (*Brent*) and gas price (*Gas*), which together explain the lion's share of the total variance of the index. We have included a lagged dependent ($HWWI_{t-1}$) to account for any commodities we do not explicitly model.

In equation (5) we have included nominal government debt (D^N), as higher debt forces a developed country to borrow on international capital markets. Moreover, the trade balance (nominal exports (X^N) minus nominal imports (M^N)) dominates the current account.

Wages

Starting point for our wage equation is a simple Phillips curve (Phillips, 1958):

$$\Delta\left(\frac{W_t}{H_t}\right) = c + \rho\Delta(\pi_{t-1}) - \sigma u_t + \varepsilon_t \qquad (6)$$

Where *W* represents wages, *H* is the amount of hours worked, π indicates inflation and *u* is the unemployment rate. From this, we ultimately estimate equation (7):

$$\Delta\left(\frac{W_t}{H_t}\right) = c + \alpha_{15}\Delta CPI_{t-1} + \alpha_{16}(U - U^*) + \alpha_{17}\left(\frac{P_{t-1}}{Y_{t-1}^N}\right) + \alpha_{18}\log\left(WUI_t\right) + \varepsilon_t \qquad (7)$$

where we use the unemployment rate versus the structural unemployment rate (U^*) as an indicator for labour market slack. We add a variable measuring the gross operating surplus of corporates (*P*) as a ratio of nominal GDP to the original Phillips curve equation, as wage growth is only possible (without forced layoffs) in case of sufficient profits. *WUI* stands for world uncertainty index, the idea being that wage demands are subdued in case of global uncertainty and volatility, as the risks of layoffs becomes higher.

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[4] The PPI has an effect on the current account as well, since a higher PPI erodes the competitiveness of an industry. We have included this effect exogenously via the trade effect.

Exchange rate

There has been much debate about whether it is possible to develop accurate exchange rate models. According to Cheung, Chinn, and Pascual (2005) and Cheung *et al.* (2018), no exchange rate model has been found to consistently outperform a random walk. However, Engle *et al.* (2007) argue that this criterion alone is insufficient to dismiss the usefulness of exchange rate models. In the literature, various approaches have been proposed, such as the covered interest rate parity, the purchasing parity, the sticky price model, the real interest rate differential, the yield curve, and the sticky price monetary model augmented by risk and liquidity factors. Our proposed model incorporates elements from these various approaches as its foundation:

$$\Delta FX_t = c + \alpha_{19}\left(\frac{CA_t}{Y_t^N}\right) + \alpha_{20}\Delta(i_t^{US} - i_t) + \alpha_{21}\Delta HWWI_t + \alpha_{22}\Delta WT + \alpha_{23}d\left(\frac{D_t^N}{Y_t^N}\right) + \alpha_{24}\Delta\left(\frac{C_t}{Y_t^N}\right) + \varepsilon_t \quad (8)$$

Where *FX* is the exchange rate against the US dollar, the interest differential is captured by α_{20} (i.e. the policy rate (i) vis-à-vis the US policy rate i^{US}). *WT* is world trade: as world trade picks up the demand for currencies such as the GBP and EUR increases, as safe haven demand ebbs. Term α_{23} captures the q-o-q mutations (*d*) of the debt ratio and C/Y^n represents the private credit to GDP ratio.

Nominal GDP and policy rates

To check whether our system produces valid outcomes, we have modelled two control variables, nominal GDP and the Central Bank policy rate. For nominal GDP, we estimate the following equation:

$$\Delta(Y_t^N) = c + \alpha_{25}\Delta CPI_t + \alpha_{26}\Delta\left(\frac{D_t^N}{Y_t^N}\right) + \alpha_{27}\Delta I_t + \alpha_{28}(\Delta W_{t-1} - \Delta CPI_{t-1}) + \alpha_{29}\Delta(X_t - M_t) + \varepsilon_t \quad (9)$$

In equation (9), besides inflation, all other variables are proxies for expenditure components of GDP. The debt ratio is indicative for the amount the headroom a government has to invest and consume. *I* stands for business investment. Lagged real wage growth is indicative for private consumption growth. Finally, we include the growth of net trade.

In order to estimate the central bank policy, we employ an equation based on a simple Taylor rule (Taylor, 1993):

$$i_t^* = r^* + \pi_t + \alpha(\pi_t - \pi_t^*) + \beta(Y_t - Y_t^*)_t \quad (10)$$

where i^* is the policy rate, r^* is the equilibrium real interest rate, π^* is the target inflation rate, and (Y-Y^*) is the output gap. Based on this equation, we estimate:

$$i_t = c + \alpha_{30}\Delta\left(\frac{W_t^N}{N_t}\right) + \alpha_{31}\Delta Y_t + \alpha_{32}\, i_t^{US} \quad (11)$$

Data sources

We use quarterly data that ranges from 1987Q1 through 2022Q3 for the UK and ranges from 1999Q1 through 2022Q3 for the Eurozone. The only exception is data on gas prices, which we only have from 2010Q2 through 2022Q3. For data that is available at a higher frequency, like data on the currency, we have used the average across the quarter.

Table 1: Data sources

Variable	*Description*	*Source UK*	*Source Eurozone*
$\boldsymbol{CPI}$	Consumer price index	ONS	Eurostat
$\boldsymbol{PPI}$	Producer price index	ONS	Eurostat
$\boldsymbol{HWWI}$	Commodity price index	HWWI	HWWI
$\boldsymbol{CA}$	Current account	ONS	ECB
$\boldsymbol{\left(\frac{W}{H}\right)}$	Nominal wages per hour	OECD	OECD
$\boldsymbol{FX}$	GBP/USD, EUR/USD	Macrobond	Macrobond
$\boldsymbol{Y^N}$	Nominal GDP	ONS	Eurostat
$\boldsymbol{i}$	Policy rate	Bank of England	ECB
$\boldsymbol{X - M}$	Trade balance	ONS	Eurostat
$\boldsymbol{\left(\frac{Y}{Y^*}\right)}$	Output gap	OBR	IMF
$\boldsymbol{\left(\frac{Y}{N}\right)}$	Labor productivity per hour	ONS	OECD
$\boldsymbol{D}$	Government debt	ONS	Eurostat
$\boldsymbol{Brent}$	Brent price	Bloomberg	Bloomberg
$\boldsymbol{Gas}$	Gas price	ICE	ICE
$\boldsymbol{WT}$	World trade	CBS	CBS
$\boldsymbol{P}$	Corporate operating surplus	OECD	OECD
$\boldsymbol{WUI}$	World uncertainty index	EIU	EIU
$\boldsymbol{i_{US}}$	Federal funds rate	Federal Reserve	Federal Reserve
$\boldsymbol{M}$	Import volumes	ONS	Eurostat
$\boldsymbol{\left(\frac{D^N}{Y^N}\right)}$	Nominal government debt to GDP	BIS	BIS
$\boldsymbol{\left(\frac{C}{Y^N}\right)}$	Private credit to GDP	BIS	BIS
$\boldsymbol{M}$	Unemployment	ONS	OECD
$\boldsymbol{U^*}$	Structural unemployment	Eurostat	Eurostat
$\boldsymbol{I}$	Business investment	ONS	OECD

Source: RaboResearch

Model results

Figure 28 shows the estimation results for our eight equations. For the UK model, all the variables in the estimated equations, have the right sign and are statistically significant. To check for statistical rigor, we have also run a number of statistical tests, including tests for stationarity, autocorrelation, and heteroscedasticity.

For the Eurozone, we are able to reproduce the same results as for the UK (figure 29), with the expectation that we have imposed the coefficients of the UK exchange rate model for the euro area exchange rate model, as we have argued before.

Figure 27: Model estimations for the United Kingdom

Independent variable ↓	*Dependent variable* →		ΔCPI_t	ΔPPI_t	$\Delta HWWI_t$	CA_t	$\Delta\left(\frac{W_t}{N_t}\right)$	ΔFX_t	ΔY_t^N	i_t
	c	Constant	0.98***	0.13	-0.60	-0.83	3.07	8.64***	2.78***	-30.25**
α_1, α_{30}	$\Delta\left(\frac{W}{H}\right)_t$	Nominal wage costs per hour	0.20***, d	-	-	-	-	-	-	0.18***, c
α_2	$(\Delta PPI_{t-2} \geq 4) \cdot (\Delta PPI_{t-2})$	PPI great equal than 4	0.50***	-	-	-	-	-	-	-
α_3	$(\Delta PPI_{t-2} < 4) \cdot (\Delta PPI_{t-2})$	PPI smaller than 4	0.19***	-	-	-	-	-	-	-
α_4	$\Delta M_t \cdot \Delta FX_{t-3}$	Import inflation	0.005**	-	-	-	-	-	-	-
α_5	DUM_t^{GFC}	GFC dummy	-5.03***	-	-	-	-	-	-	-
α_6	ΔPPI_{t-1}	Lagged dependent	-	0.46***	-	-	-	-	-	-
$\alpha_7, \alpha_{10}, \alpha_{21}$	$\Delta HWWI_t$	Commodity index	-	0.07***	0.16***, a	-	-	-0.10***, b	-	-
α_8	$\left(\frac{Y_t}{Y_t^*}\right)$	Output gap	-	0.44*	-	-	-	-	-	-
α_9, α_{19}	$\left(\frac{CA_t}{Y_t^N}\right)$	Current account to GDP ratio	-	-0.17	-	-	-	2.96***	-	-
α_{11}	$\Delta Brent_t$	Brent price	-	-	0.45***	-	-	-	-	-
α_{12}	ΔGas_t	Gas price	-	-	0.18***	-	-	-	-	-
α_{13}	D_t^N	Nominal debt	-	-	-	-0.009***	-	-	-	-
α_{14}	$X_t^N - M_t^N$	Trade balance	-	-	-	0.44***	-	-	-	-
α_{15}, α_{25}	ΔCPI_t	Consumer price index	-	-	-	-	0.77***, c	-	0.64***	-
α_{16}	$U_t^{\square} - U_t^*$	Labour market tightness	-	-	-	-	-1.11***	-	-	-
α_{17}	$\Delta\left(\frac{P_{t-4}}{Y_{t-4}^N}\right)$	Operating surplus as ratio of GDP	-	-	-	-	0.64***	-	-	-
α_{18}	WUI_t	World uncertainty index	-	-	-	-	-1.40***	-	-	-
α_{20}	$\Delta(i_t^{US} - i_t)$	Interest rate differential	-	-	-	-	-	-1.92***	-	-
α_{22}	ΔWT_t	World trade	-	-	-	-	-	0.56***	-	-
α_{23}, α_{26}	$\Delta\left(\frac{D_t^N}{Y_t^N}\right)$	Debt ratio	-	-	-	-	-	-0.32	-0.28***	-
α_{24}	$\Delta\left(\frac{C_t^{\square}}{Y_t^N}\right)$	Private sector credit to GDP ratio	-	-	-	-	-	-0.46***	-	-
α_{27}	ΔI_t	Investment	-	-	-	-	-	-	0.16***	-
α_{28}	$\Delta W_{t-2} - \Delta CPI_{t-2}$	Real wage growth	-	-	-	-	-	-	0.14***	-
α_{29}	$\Delta(X_t - M_t)$	Net export growth	-	-	-	-	-	-	0.06***	-
α_{31}	ΔY_{t-3}	Economic growth (constant prices)	-	-	-	-	-	-	-	0.13**
α_{32}	i_t^{US}	US policy rate	-	-	-	-	-	-	-	0.89***
ϑ	T_t	Trend term	-	-	-	-	-	-	-	-
	$Adj - R^2$		0.65	0.68	0.99	0.72	0.73	0.52	0.67	0.80

Note: All estimates are with HAC standard errors and covariance. Significant at *10%; **5%; ***1%. a: lag of one quarter, b: lag of two quarters, c lag of three quarter, d a lag of 7 quarters.
Source: RaboResearch

Figure 28: Model estimations for the Eurozone

Independent variable ↓		*Dependent variable →*	ΔCPI_t	ΔPPI_t	$\Delta HWWI_t$	CA_t	$\Delta\left(\frac{W_t}{N_t}\right)$	ΔFX_t	ΔY_t^N	i_t
	c	Constant	0.57**	-1.17	-0.59	-42.14	-5.90	1.46#	-0.78	-32.06***
α_1, α_{30}	$\Delta\left(\frac{W}{H}\right)_t$	Nominal wage costs per hour	0.40***	-	-	-	-	-	-	0.23***, c
α_2	$(\Delta PPI_{t-2} \geq 4) \cdot (\Delta PPI_{t-2})$	PPI great equal than 4	0.22***	-	-	-	-	-	-	-
α_3	$(\Delta PPI_{t-2} < 4) \cdot (\Delta PPI_{t-2})$	PPI smaller than 4	0.18***	-	-	-	-	-	-	-
α_4	$\Delta M_t \cdot \Delta FX_{t-3}$	Import inflation	-	-	-	-	-	-	-	-
α_5	DUM_t^{GFC}	GFC dummy	-	-	-	-	-	-	-	-
α_6	ΔPPI_{t-1}	Lagged dependent	-	0.09	-	-	-	-	-	-
$\alpha_7, \alpha_{10}, \alpha_{21}$	$\Delta HWWI_t$	Commodity index	-	0.09***	0.16***, a	-	-	-0.10#	-	-
α_8	$\left(\frac{Y_t}{Y_t^*}\right)$	Output gap	-	0.61**	-	-	-	-	-	-
α_9, α_{19}	$\left(\frac{CA_t}{Y_t^N}\right)$	Current account to GDP ratio	-	-0.44**	-	-	-	1.46#	-	-
α_{11}	$\Delta Brent_t$	Brent price	-	-	0.45***	-	-	-	-	-
α_{12}	ΔGas_t	Gas price	-	-	0.18***	-	-	-	-	-
α_{13}	D_t^N	Nominal debt	-	-	-	0.0008	-	-	-	-
α_{14}	$X_t^N - M_t^N$	Trade balance	-	-	-	0.90***	-	-	-	-
α_{15}, α_{25}	ΔCPI_t	Consumer price index	-	-	-	-	0.22***, b	-	0.89***	-
α_{16}	$U_t - U_t^*$	Labour market tightness	-	-	-	-	-0.27***	-	-	-
α_{17}	$\frac{P_t}{GDP_t}$	Operating surplus as % of GDP	-	-	-	-	0.18**	-	-	-
α_{18}	WUI_t	World uncertainty index	-	-	-	-	-	-	-	-
α_{20}	$\Delta(i_t^{US} - i_t)$	Interest rate differential	-	-	-	-	-	-1.92#	-	-
α_{22}	ΔWT_t	World trade	-	-	-	-	-	0.56#	-	-
α_{23}, α_{26}	$\Delta\left(\frac{D_t^N}{Y_t^N}\right)$	Debt ratio	-	-	-	-	-	-0.32#	-0.05	-
α_{24}	$\Delta\left(\frac{C_t}{Y_t^N}\right)$	Private sector credit to GDP ratio	-	-	-	-	-	-0.46#	-	-
α_{27}	ΔI_t	Investment	-	-	-	-	-	-	0.40***	-
α_{28}	$\Delta W_{t-2} - \Delta CPI_{t-2}$	Real wage growth	-	-	-	-	-	-	0.45***	-
α_{29}	$\Delta(X_t - M_t)$	Net export growth	-	-	-	-	-	-	1.39***	-
α_{31}	ΔY_{t-3}	Economic growth (constant prices)	-	-	-	-	-	-	-	0.10**, b
α_{32}	I_t^{US}	US policy rate	-	-	-	-	-	-	-	0.07
ϑ	T_t	Trend term	-	-	-	-	-	-	-	-0.03***
	$Adj - R^2$		0.81	0.71	0.99	0.84	0.77	x	0.82	0.69

Note: All estimates are with HAC standard errors and covariance. Significant at *10%; **5%; ***1%. a: lag of one quarter, b: a two quarter lag, c: a lag of five quarters. # coefficients are imposed from the estimates for the UK. We abstract from the COVID-19 period in the estimation for the PPI and wage equations.
Source: RaboResearch

Assumptions on exogenous variables

Not every variable that we use in our set of equation is determined endogenously. For those variables we briefly describe how we have extended the data to match with our forecasting horizon.

In-house forecasts

For quite a few variables (such as world trade, business investment, the Federal funds rate, import and export volumes and the unemployment rate) we use our in-house forecasts. For the latest forecasts, we refer to our monthly outlook.

Output gap and potential growth

In our side model, we determine the output gap by comparing GDP growth to potential GDP growth, which we determine by applying a Hodrick-Prescot filter to the historical series of economic growth. Based on these estimations, we expect that the output gap remains negative for both the UK as the Eurozone, as we expect a mild recession in 2023 and a sluggish economic recovery afterwards. On a side note: we have also experimented with output gap estimations by ONS and the OECD, but this did not result in useful outcomes.

As structural shocks, such as a de-industrialization scenario, is also affecting potential growth, we have imposed a shock to the supply block in NiGEM. This is based on sector composition shifts, where part of the labour force moves from the highly productive manufacturing sector to other parts of the economy where productivity per hour is lower. An obvious caveat in our research is that we do not impose additional shocks to potential output based on, for instance destruction of R&D capital, which would have a substantial impact on potential growth and also seems realistic under the de-industrialization scenario.

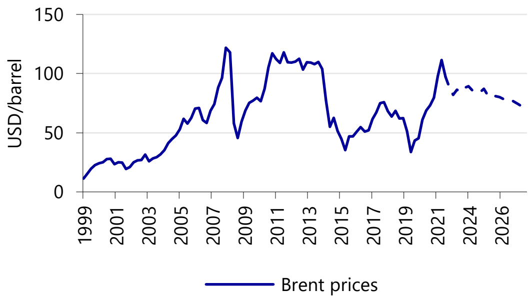
Labour market tightness

The tightness of the labour market is computed by comparing the actual unemployment rate with the natural rate of unemployment. The latter is forecasted by the Eurostat and where an estimate of the natural rate of unemployment was not available, we have estimated the natural rate of unemployment by applying a Hodrick-Prescot filter to the unemployment rate. Despite a mild economic recession, we expect the labour market to remain tight in both the UK and the Eurozone for the foreseeable future.

Oil and gas price

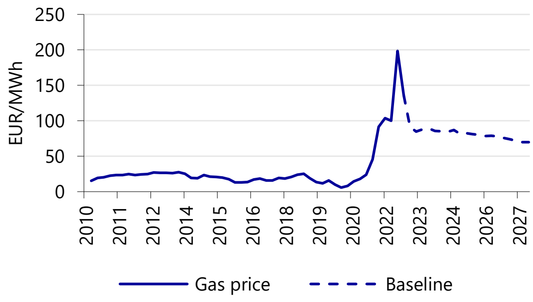
Energy prices are based on our in-house forecasts. Currently, it is quite hard to estimate where prices will be next month, let alone next year, but these figures are our best estimates and align quite well with what markets are pricing in.

Figure 29: Forecast for Brent prices



Source: RaboResearch

Figure 30: Forecast for TTF 1-month forward



Source: Bloomberg, RaboResearch

Debt ratio

We have used figures from the IMF for our debt ratio projections. For both the UK and the Eurozone the debt ratio falls somewhat after 2022, driven by high nominal economic growth (which in turn is driven by higher than usual inflation).

Credit to GDP ratio

We use an ARIMA model to forecast the credit to GDP ratio. For both the UK and the Eurozone the ratio remains relatively flat in the coming years at pre-COVID levels.

Appendix B: Assumption on subsidies, industry

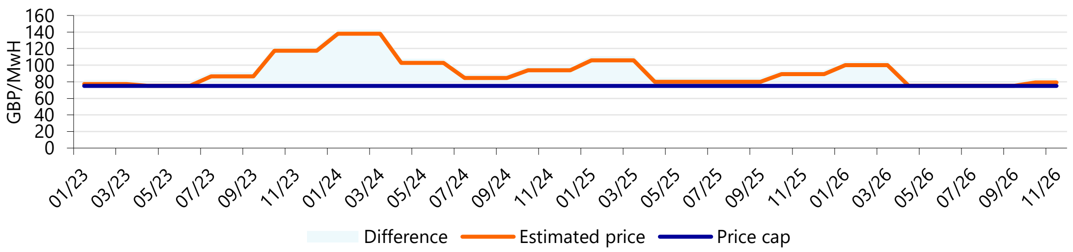
We have constructed two potential risk scenario's for both the United Kingdom and the Eurozone.

Subsidies to gas and electricity use

If the government were to provide subsidies for the purchase of gas and electricity by industry, consumers and other organizations, this would have an effect on the exchange rate via the current account, which is then impacted by a greater government debt ratio (as the extra government spending will have to be financed by foreign investors).

We have compared the forward curves for gas and electricity with the price cap levels that have been previously proposed and assumed that these measures will be continued until 2027 in order to calculate the cost (and consequently the effect on debt) for this scenario. The cost is based on the volume in addition to the subsidy that is needed per unit of volume. We have assumed that the economy will be able to keep running at 90% of the energy use of 2019. Since the price incentive to reduce demand will be taken away, we assume that prices will rise by 20%. We have aggregated the costs for the Eurozone on a country-by-country basis, using Bruegel's helpful analysis of the national fiscal policy response. For countries that do not have an explicit subsidy level in place, we use a subsidy level of a country that is similar in terms of wealth and energy mix.

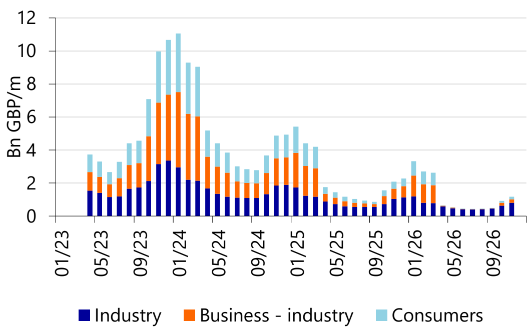
Figure 31: Companies and households can continue to benefit from subsidies in this scenario



Source: Bloomberg, RaboResearch

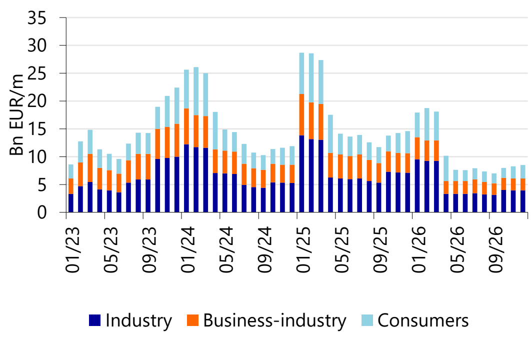
The total cost for the UK amount to GBP85bn, around 0.8% of GDP for the period 2023-2027. The bulk of these subsidies will be in the first few years since the we expects energy prices to decline in the coming years. Before the price stabilises, it is likely to have dipped below the subsidy level however, which means that the cost will be zero from that point onward. We have made a similar calculation for the subsidy cost for the Eurozone. The total cost amount to EUR700bn, equal to roughly 1% of GDP for the period 2023-2027. This is relatively higher than the cost for the UK, but this difference can be explained from the fact that the UK has a relatively small industrial sector (only 10% of TVA), whilst the Eurozone economy is highly industrialized (roughly 20% of TVA). The industrial sector accounts for a relatively large share of energy usage.

Figure 32: Additional cost for the UK



Note: Additional costs for the first few months are zero because those subsidies are already in place
Source: ONS, UK government website

Figure 33: Cost for the Eurozone



Source: Eurostat, National governments, Bruegel

De-industrialization scenario

We assume lower production in various industrial sectors when considering the deindustrialization scenario. In this scenario, we anticipate a 10% industrial production decline in the UK and the Eurozone. We assume that energy-intensive production in US increases so that on a global scale energy demand stays unchanged vis-à-vis baseline. Logically, not every industrial sector is as vulnerable to these higher energy prices. Consequently, we have divided the pain based on the relative energy intensity.

$$P_{\%,i} = \left(\frac{EI_i}{EI_{average}}\right)^{\frac{1}{3}}; \qquad EI_i = \left(\frac{E_i}{E_T}\right) / \left(\frac{TVA_i}{TVA_T}\right) \tag{12}$$

Where $P_{\%}, i$ denotes the percentual shock applied to subsector i, EI_i denotes the energy intensity of sector i, and $EI_{average}$ the average energy intensity of the industrial sector. The energy intensity is defined as the ratio of the share of total energy consumption to the share of total value added.

Reduced industrial output results in decreased exports and (sometimes) increased imports. We have assumed that the domestically available production (i.e., production plus import minus export) should remain constant. So we adjust exports for the lost production and adjust imports for the intermediate products needed for the lost production. If the lost production exceeds the nominal value of the exports, we will need to replace that production by imports.

$$XVOL_s = \max(0, XVOL_h - P_s); \qquad MVOL_s = DD_h - (P_l - XVOL_s) \tag{13}$$

Where $XVOL_s$ are the exports after the shock, $XVOL_h$ are the non-shocked exports, P_s is the shock to production, DD_h is the domestic demand and $MVOL_s$ are the imports after the shock.

Using this methodology, we see that even a small shock can completely evaporate the exports of a sector, basically forcing it to produce for the domestic market. In reality, there will always be companies that export a part of the production in a sector, however. Since our model takes net trade effects into account, this does not have an effect on the outcome.

Table 2: Production cuts UK industry

Industry	Gas/TVA ratio	Production*	Production cut	Import shock	Export shock**
Food products	1.3	GBP 97bn	10%	-10%	-66%
Textiles, clothing	0.9	GBP 12bn	5%	-7%	-32%
Wood, paper,	0.7	GBP 37bn	10%	7%	-100%
Coke and	4.2	GBP 98bn	20%	-2%	-44%
Chemicals	4.2	GBP 41bn	20%	-13%	-43%
Pharmaceuticals	0.6	GBP 32bn	5%	-24%	-23%
Rubber & plastic	1.3	GBP 26bn	15%	-16%	-34%
Non-metallic	3.7	GBP 20bn	20%	13%	-100%
Basic metals	0.7	GBP 54bn	10%	-16%	-47%
Computer,	0.3	GBP 21bn	5%	-10%	-28%
Electrical	0.9	GBP 15bn	5%	-11%	-29%
Machinery and	1.8	GBP 37bn	10%	-17%	-23%
Transport	0.5	GBP 75bn	5%	9%	-11%
Other	0.1	GBP 64bn	5%	-26%	-31%
Total				-2.5%	-7.6%

* Please note that production is in nominal terms and is not in value added terms.
** Some of the shocks to export may seem extreme, but can be explained from the fact that a lower production first hits exports, basically forcing those sectors to produce for domestic demand.
Source: RaboResearch

Table 3: Industrial cuts for the Eurozone

Industry	Gas/TVA ratio	Production*	Production	Import shock	Export shock**
Food products	3.1	EUR 813bn	11%	-20%	-72%
Textiles, clothing	1.4	EUR 170bn	9%	-13%	-28%
Wood, paper	3.8	EUR 279bn	11%	-32%	-65%
Coke and	21.6	EUR 297bn	20%	-9%	-77%
Chemicals	7.3	EUR 450bn	15%	-19%	-44%
Pharmaceuticals	2.5	EUR 245bn	10%	-25%	-20%
Rubber &	3.0	EUR 223bn	11%	-32%	-45%
Non-metallic	10.5	EUR 157bn	16%	-1%	-99%
Basic metals	1.7	EUR 702bn	9%	-39%	-44%
Computer,	0.8	EUR 230bn	7%	-10%	-15%
Electrical	0.8	EUR 223bn	8%	-23%	-21%
Machinery and	1.4	EUR 552bn	10%	-20%	-23%
Transport	0.4	EUR 875bn	6%	-9%	-17%
Other	0.7	EUR 342bn	6%	-51%	-30%
Total economy				-9%	-21%

* Please note that production is in nominal terms and is not in value added terms.
** Some of the shocks to export may seem extreme, but can be explained from the fact that a lower production first hits exports, basically forcing those sectors to produce for domestic demand.
Source: RaboResearch, Eurostat

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