The PUFFIN Project

Briefing pack for participants
About the Institute for Innovation and Public Purpose

The UCL Institute for Innovation and Public Purpose (IIPP) aims to develop a new framework for creating, nurturing and evaluating public value in order to achieve economic growth that is more innovation-led, inclusive and sustainable.

We intend this framework to inform the debate about the direction of economic growth and the use of mission-oriented policies to confront social and technological problems. Our work will feed into innovation and industrial policy, financial reform, institutional change, and sustainable development.

A key pillar of IIPP’s research is its understanding of markets as outcomes of the interactions between different actors. In this context, public policy should not be seen as simply fixing market failures but also as actively shaping and co-creating markets. Re-focusing and designing public organisations around mission-led, public purpose aims will help tackle the grand challenges facing the 21st century.

IIPP is housed in The Bartlett, a leading global Faculty of the Built Environment at University College London (UCL), with its radical thinking about space, design and sustainability.
Priming public sector financial institutions for the green transition (PUFFIN)

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1. Introduction

The twenty-first century is becoming increasingly defined by the need to respond to major social, environmental, and economic challenges. Sometimes referred to as “grand challenges,” these include demographic, health and well-being concerns, and the difficulties of generating sustainable and inclusive growth. Among these challenges, none is greater than the climate crisis and the need to keep global temperatures within the 1.5 degree increase agreed in the Paris Accord.

Moving towards a greener zero carbon economy means re-directing all sectors and all actors – public, private and civil society – towards economic growth in a sustainable and inclusive direction. The European Commission’s recently published European Green Deal estimates that achieving its 2030 climate and energy targets will require €260 billion of additional annual investment, which is about 1.5% of European GDP.¹

Like all investment, this must be financed. But finance is not neutral; the type of finance available can affect both the investments made and the type of activity that occurs.² ³ The types of financial institutions and markets that exist have a material impact on activity in the real economy. As with previous industrial and technological transformations, the role of the public sector will be key.⁴

The next three years represent a critical window to shift financial flows towards the green transition. The PUFFIN project aims to identify barriers and enablers for the financing of the green transition, and to use these insights to influence the missions, mandates, policies and activities of public sector financial institutions (PSFIs) to align them with climate objectives. While PSFIs are often addressed separately on climate issues and in a vacuum from the real economy green actors, the PUFFIN project will bring them together into one financial ecosystem by examining the role of PSFIs across three different levels of the financial system:

- Macro level finance: Monetary and macroprudential policy as conducted by central banks and financial regulators.
- Meso level finance: The provision of long-term patient finance by state investment banks and other public financial institutions.
- Micro level finance: Firms seeking finance to invest in green innovation projects.

In this briefing paper, we introduce the macro-meso-micro framework, and set out some of the key questions that will be examined in the PUFFIN project.
2. Macro finance and the climate crisis

In most advanced economies, central banks are the only institutions with formal powers to influence the flow of new money and credit in the economy. They also have responsibility over large swathes of financial regulation and their powers enable them – should they choose – to influence the allocation of private sector credit and financial flows generally.

But while central banks have played an increasingly interventionist role in our economies since the financial crisis, this has not coincided with any significant adjustment of their policies in support of financing a zero-carbon transition. However, there has recently been an explosion of research and policy analysis by central banks in this field, with a particular emphasis on the way in which climate-related financial risks (CRFR) may impact on central banks established financial stability mandates.5

1.1 What modern central banks do

Central banks are public institutions and their mandates are usually determined by governments. Since the 1990s their mandates have been strongly focused on price stability, typically an inflation target of around 2%. Since the 2008 financial crisis, there has been an acceptance that this must be balanced at all times with ensuring financial stability. One of the key lessons of the crisis was that price stability can coincide with the build-up of excessive financial risk. A recent global survey found that only 12% of central banks have explicit sustainability mandates, while 29% are mandated to support the government's policy priorities, which in most cases include sustainability goal.6

Since the 1990s, most central banks in advanced economies have been granted 'operational independence', meaning they are free to apply their toolkit to pursue the goals set by politicians in whatever fashion they prefer. Generally speaking, central banks influence the economy through:

1) Monetary policy, which involves influencing the flow of money and credit in the economy in order to achieve price stability (i.e. preventing excessive inflation or deflation). This is achieved via adjustments to interest rates and the purchase or selling of existing financial assets (such as government or commercial bonds) via central bank money creation. The latter has been conducted on a very large scale since the financial crisis via Quantitative Easing programs.
2) Financial regulation, which defines the rules for financial institutions at both the individual level (prudential policy) and at the systemic level (macroprudential policy) to safeguard financial stability. These can include rules around the amount and type of equity capital and liquidity banks must hold relative to their loans in case of defaults. It may also include specific restrictions on certain types of lending, e.g. quantity controls on certain types of lending.

1.2 Why central banks are essential to the zero-carbon transition

Much of the current policy narrative relating to green finance focuses on capital markets and the need to direct existing pools of capital towards greener sources. Rather less attention has been paid to the role of monetary policy and financial regulation. In this section, we summarise some of the key reasons why central banks and financial regulators have a key role to play in supporting the green transition.

1.2.1 Central banks are public institutions with a responsibility to support wider public objectives

Although their primary objectives are predominantly price and financial stability, most central banks also have secondary objectives around supporting the general objectives of government. The rapid transition to a zero-carbon economy is one such objective, as is mandated by the 2015 Paris Agreement.

The role of central banks is not carved in stone: it has changed through history. The first central banks were established to enhance the financial power of the sovereign — primarily to help finance wars; and in some cases, to help develop financial markets and promote local economic activity. Over time, the roles and responsibilities of central banks have ebbed and flowed in response to economic events and changing monetary theory and practise.

For the majority of the 20th century, central banks have had a range of different objectives within their mandates. These included high or full employment, managing and reducing government deficits, supporting strategic industrial sectors and exchange rate stability as well as price and financial stability. For example, central banks worked closely with ministries of finance to support post-war reconstruction and investment in infrastructure and small and medium sized enterprises.
Central bank responsibilities have always been focused on the economic context and challenges at hand. Since climate change is one of the greatest and most urgent challenges facing modern economies, there is a strong argument that it should be integral to central bank policy agendas, even aside from the legal obligations facing all signatories to the Paris Agreement.

1.2.2 Government finance alone will be insufficient to achieve a net zero-carbon transition

A successful transition will only be possible if all the agents of the state and financial sector act collaboratively in the same direction and bring the market with them. Ministries of finance, regulators, and central banks need to coordinate their activities and adapt their policies to address climate change, ensuring the credit and monetary system is fully aligned with the transition to a zero-carbon economy.

One argument against central banks incorporating climate change in to their policy agenda is that it is unnecessary and the ‘job of government’ or financial markets more generally. But the investment required to a low carbon transition is vast. As shown in Figure 1, the total infrastructure investment required for a successful zero-carbon transition from 2015 until 2030 is estimated to be around the $95 trillion mark. Therefore, on an annual basis, investment would have to more than double from around current actual investment of $3 trillion to just under $7 trillion every year\textsuperscript{12}. The extent of this challenge is put into perspective by the fact that the required investment is nearly twice the value of the total global infrastructure stock (approximately $50 trillion)\textsuperscript{13}. 
Market-based attempts at boosting green finance, such as the creation of carbon trading schemes, have been largely disappointing.\textsuperscript{14} There is also considerable resistance to a carbon tax from vested interests.

A mixture of high-risk-appetite and very long-term, patient capital is needed, on a huge scale. Government spending and taxation (fiscal policy) and existing flows of private finance are unlikely, on their own, to be consistent with what is needed for a 1.5 degrees transition.\textsuperscript{15} Economic growth remains sluggish with high levels of public and private debt relative to GDP and uncertainty about the future due to a lack of policy credibility.\textsuperscript{16} All of these dynamics are likely to mitigate against the kind of patient capital required for a rapid zero-carbon transition.

Given this, the role of finance takes on an ever more important role in driving forward innovation and radical shifts in production. Historical evidence suggests this is unlikely to come from the large, incumbent ‘status quo’ industries with easy access to finance. Rather, radical innovation is likely to come from small and medium sized enterprises (SMEs) — supported by government policy — that are most dependent on bank finance since they are unable to raise money on capital markets. Financial regulation could be used to steer bank credit towards these sectors.
1.2.3 Financial stability concerns

It is now widely accepted that climate change poses serious threats to financial stability and as such is material to central banks and financial supervisors’ mandates.\textsuperscript{17\textsuperscript{-}19 20} Such recognition was a key catalyst in the creation of the Network for Greening the Financial System (NGFS), an international grouping of 54 central banks, financial supervisors and observers focused on how financial policy\textsuperscript{21} needs to adjust to support a smooth net-zero carbon transition.

A consensus is now emerging as to the nature of climate-related financial risks (CRFR) involving both physical, transition and liability risks.\textsuperscript{22 23}

- Physical risks refer to the impacts of climate related weather events (e.g. droughts, floods, and storms) that could have a profound impact on the productive economy. For example, disrupting global supply chains, resource availability, and entire industries\textsuperscript{24}. With scientists virtually certain that we will experience an increase in certain extreme weather events in the future, physical and liability risks will become even more pronounced.

- Transition risks arise from the processes of mitigation and adjustment towards a lower-carbon economy, which are likely to have significant effects on carbon intensive sectors. Forecasts suggest that only one fifth of remaining fossil fuel reserves (oil, gas, and coal) can be burned if we are to keep temperatures below 2°C\textsuperscript{25}. If the Paris Agreement is met, most of these reserves will have to be left in the ground; fossil fuel companies may be hugely overpriced, and infrastructure built to extract the reserves may become useless — known as stranded assets.

- Liability risks are the types of risks that may arise when individuals or businesses suffer losses/damages related to climate change, and look to hold certain entities responsible. Third party liability insurance also means this risk could be significant to insurance sectors\textsuperscript{26}.

Climate related financial risks are unique in that they are characterised by far-reaching impact, unforeseeable nature and irreversibility. They are also systemic as they have the potential to affect the entire economy and financial system.\textsuperscript{27}
But how to deal with such risks, in particular transition risks involving structural changes to the economy on the path towards net-zero carbon emissions, is an emerging area. One particular challenge is the measurement and forecasting of CRFR in a way that supports effective interventions. In particular, there is a timing problem whereby, as noted in the first NFGS policy report, whilst “…the risks call for action in the short-term to reduce impact in the long-term […] there is a need to build intellectual capacity in translating the science into decision-useful financial risk assessment information”. 28

The emerging policy framework for dealing with CRFR has so far focused mainly on market-correcting strategies. CRFR are perceived to be under-priced in existing financial markets — or not priced at all — and financial markets are viewed as too short-termist in their outlook. Hence policy has focused on encouraging financial institutions to examine and disclose CRFR — most notably through the Task Force on Climate Related Financial Disclosures (TCFD) and, more recently, encouraging scenario analysis and stress-testing. 29 However, many questions remain open around the assumptions that should be used to determine different scenarios and what the outcomes of scenario modelling and stress testing results actually mean for policy interventions, beyond sending useful signals to markets. In the most recent report of the Network for Greening the Financial System (NGFS), the only concrete policy proposal going forward is to “develop voluntary guidelines on scenario-based risk analysis” that individual central banks and supervisors may use to inform their policy frameworks. 30 In other words, whilst it is preferable to act now, it may not be possible to do so since there is insufficient intellectual capacity to understand the nature of CRFR and how policy interventions may affect their development.

The current Governor of the Bank of England, Mark Carney, has suggested that the stranded assets problem could result in a ‘climate Minsky moment’ involving a rapid, system-wide (downward) repricing of carbon assets which would threaten financial stability 31. For example, approximately 30% of the market value of the FTSE 100 stock exchange is derived from oil, gas and mining companies.

Importantly, stranded assets would not only have a direct detrimental impact on fossil fuel companies, but also the institutions that have invested or financed them and other industries that are dependent on the fossil fuel sector 32. It is worth noting that fossil fuel assets might not only become ‘stranded’ due to new regulation and government policies, but also changes in consumer preferences, resistance by communities (e.g. fracking in the UK 33) and technological innovations (e.g. growth of electric cars industry 34).
1.2.4 Central banks as long-term stewards of the economy and sustainable economic development

The three types of risk identified above are interdependent. The more fossil fuels we continue to extract and burn, the greater the liability and physical risks of climate change. We either proactively manage the transition risk on our own terms, or expose our economies to the incalculable economic cost of an unwinding climate system. Either way, it is a matter of the utmost significance for those tasked with delivering a stable and resilient financial system.

Lord Nicholas Stern has described climate change as the world’s ‘greatest market failure’, which risks unprecedented social and economic costs ‘on a scale larger than the two world wars of the last century’\(^{35}\). The evidence suggests that a voluntary approach to risk disclosure may not be sufficient to generate a step change in investment and bank lending behaviour.\(^{36}^{37}^{38}\) Recent analysis shows that the world’s largest investment banks have provided more than $700bn of financing for the fossil fuel companies most aggressively expanding in new coal, oil and gas projects since the 2015 Paris climate change agreement.\(^{39}\) Carbon intensive activities of course benefit the financiers, producers, and consumers involved in the economic transactions but the environmental costs of burning these fossil fuels are indirectly imposed on the rest of society\(^{40}\). Given central banks’ ability to influence financial flows and bank lending, these environmental market failures create a strong argument for central banks to implement preventative or corrective policies\(^{41}\).

Another form of market failure is the notion of ‘missing markets’, where free markets fail to allocate financial resources efficiently — or in a way that is most beneficial for society. The green financing gap (figure 1) is evidence that despite governments’ intention to act on climate change, markets will not necessarily follow suit. Signals from central banks are critical for correcting this. Historically central banks in advanced economies played an important role in developing financial markets. Where green finance is essentially missing, central banks may have a role, working with ministries of finance, in helping to develop green financial markets.

More generally, in order to deal with major global challenges like climate change, the state needs to see its role as a proactive market maker and shaper as well as simply correcting market failures\(^{42}\).
Finally, climate change is a complex process, the impacts of which could be unpredictable and non-linear (i.e. the potential for ‘tipping points’ that create runaway feedback loops, like the melting of permafrost unleashing potent methane into the atmosphere). Markets are ill-equipped to deal with such dynamics. Financial analysis is generally calibrated on specific short-term time frames\textsuperscript{43}. While long-term investors (are supposed to) seek returns over a 15-30 year time horizon, financial analysts focus on the next 1-5 years. According to research by the 2 Degrees Lending Initiative\textsuperscript{44}, “Non-cyclical, non-linear risks that will only materialise after the forecast [analysis] period are likely to get missed by analysts and therefore mispriced by markets”.

It is not just financial analysts’ horizons that are too short. Political cycles create inherent pulls to the short-term. Central banks’ independence — from both short term political and market drivers — should in theory allow them to focus on the long-term financial stability issues associated with climate change.

\subsection*{1.2.5 Monetary policy and the zero-carbon transition}

Central banks have expanded their monetary policy interventions significantly since the financial crisis of 2008 in the face of economic stagnation. New money has been created — ‘printed’ in the pre-digital terminology — and pumped into the economy to stimulate the purchase of assets and thus, indirectly, wider spending. The world’s major central banks have expanded their balance sheets by roughly 35\% of the GDP\textsuperscript{45}. However, central banks have generally not aligned their policy objectives with the threats of climate change. Indeed, some central bank policy is even having unintended negative implications for the environment.

For example, the European Central Bank (ECB) Quantitative Easing (QE) programme has involved the creation of over €2.5 trillion Euros to purchase government and corporate bonds and other financial assets (ECB currently holds €177 billion of corporate bonds). Similarly, the Bank of England runs a £445 billion QE programme; while the majority of purchases have been government bonds, it also holds £10 billion in corporate bonds.

In both cases, these corporate bond purchases are intended to be ‘market-neutral’: central bank purchases are determined by similar criteria that are used by market investors. Environmental sustainability is not incorporated into this criteria. As a result, these programmes are not ‘climate-neutral’, but instead disproportionately skewed towards high-carbon sectors. A study\textsuperscript{46} by the London School of Economics found that:

- 62\% of ECB corporate bond purchases were from manufacturing, electricity and gas sectors, which are responsible for almost 60\% of eurozone greenhouse gas emissions but only 18\% of Gross Value Added\textsuperscript{47} (GVA).
Nearly 50% of the Bank of England's purchases were from manufacturing and electricity sectors, generating 52% of emissions but providing just 11.8% of GVA.

This matters because by intervening in financial markets to purchase — albeit unintentionally — carbon-intensive assets, central banks QE purchases are supporting the very carbon lock-in discussed in section 1.3, potentially reinforcing the current arrangement of energy systems centred upon fossil fuels. Finally, by inadvertently subsidising carbon-intensive industries, cleaner green alternatives are indirectly discouraged. Renewable energy companies and other types of green bonds are virtually un-represented in the corporate bond holdings of the Bank of England and the ECB.

1.3 How central banks can support a zero-carbon transition

Central banks are in a powerful position to support and accelerate a zero-carbon transition both via monetary policy and financial regulation. Their activities can strengthen financial system resilience, so that policy responses help the financial system absorb shocks, whilst also adapting and transforming it so that it is less susceptible to future risks of climate change.

Some central banks have already taken tentative steps to incorporate climate change into their operations, while others are currently considering how their activities need to change. In Europe, Christine Lagarde, the new President of the European Central Bank (ECB), recently indicated a desire to move the ECB beyond its traditional remit of controlling inflation to take greater consideration of climate risks.

Despite these noble aims, there remains little consensus about what central banks should be doing to support the zero carbon transition. There is therefore an urgent need to build consensus among financial policymakers about how central bank mandates, policies and activities need to change to align with climate objectives.

In the below section we highlight some of the potential interventions that central banks could pursue to help achieve these goals, based on existing IIPP research, as well as some questions that we will seek to explore further as part of the PUFFIN project.
1.3.1 Green macroprudential policy

In the run up to the global financial crisis of 2007-08, a small number of economists warned that the build-up of credit in the real estate and financial sector was unsustainable and posed serious risks to the financial system. They were ignored. Economists and central bankers argued it was not possible to know a bubble had occurred until after it had burst, or that credit expansion was a benign and natural outcome of an increasingly sophisticated understanding of risk within the financial sector.

The crisis made clear that this approach was deeply flawed. Left to their own devices, financial markets were prone to excessive risk-taking with potentially disastrous consequences for the real economy as well as the financial sector itself. A new approach was required. Whereas traditional financial regulation focused on the safety of individual institutions (prudential policy), the crisis made it clear that there were system-wide macroeconomic risks — including for example the build-up of mortgage debt and house prices relative to incomes across a whole economy — which also required monitoring and, where necessary, pre-emptive intervention.

A new policy approach to financial regulation was necessary, one that did not simply focus on the safety of individual institutions, but that aimed to mitigate the systemic financial risks to the macroeconomy as a whole. This approach is known as ‘macroprudential’ policy.

A key feature of macroprudential policy is that it empowers central banks to reduce the emergence of instability in the first place, allowing central banks to make interventions in the opposite direction of the lending activity of the market. In other words, central banks are given powers to reign in those activities that lead to bubbles, cyclical swings, and economic shocks.

Specific policies include increasing the commercial banking sector’s capital requirements, e.g. by forcing banks to hold a higher portion of capital against certain types of loans they make. For example, when mortgage credit growth is high relative to household incomes — indicating a heightened risk of financial instability — capital requirements might be raised to limit the rate of growth in new mortgage lending. In fact, evidence suggests that capital requirements placed on mortgage lending in Switzerland have helped curb the rate of new lending.

Similarly, macroprudential policy may involve implementing quantitative limits on certain type of banks loans. In more colourful terms, the job of the central bank is to ‘take away the punchbowl’ when the party was beginning to get out of control.
The opportunity is to ‘green’ macroprudential policy by applying similar constraints on brown lending. Very few central banks do so at the present (Brazil being one exception- see box) but many are conducting in research in to how to do this. The most obvious policy intervention would be the imposition of increased capital requirements (the amount of shareholder equity banks are required to hold for a given amount of assets) against loans carrying carbon-risk (brown loans). The latter was advocated by the recent interim report of the EU high-level expert group on sustainable finance:

“A ‘brown-penalising’ factor, raising capital requirements towards sectors with strong sustainability risks, would yield a constellation in which risk and policy considerations go in the same direction. Moreover, it would be more focused and easier to rationalise as capturing the risk of sudden value losses due to stranded assets.”

Alternatives to simply raising capital requirements on carbon-intensive loans would be to implement a counter-cyclical buffer, which simply means requiring banks to hold increasing amounts of capital as the growth rate of lending to carbon intensive sectors increases; or to introduce direct limits on credit extension to businesses that are severely reliant on fossil fuels.

From a systemic risk perspective, these sorts of measures could help to reduce carbon emissions that are yet to be priced-in, and would help central banks curb the threat of a carbon bubble.

To bridge the gap between research and policy action, we believe it necessary to make the case for a different understanding of ‘climate risk’ at the macroeconomic level. Risk is generally understood in mainstream economics and financial modelling to mean ‘probabilistic risk’, meaning random (and thus unknowable) outcomes with knowable probabilities. But, we would argue, climate risk – physical risk and in particular transition risk – is actually closer to involving random outcomes with unknowable probabilities, i.e. a situation of uncertainty rather than risk.

Transition risk can involve technological innovations (e.g. a sudden breakthrough in battery technology), changes in legislation and regulation (e.g. the rapid implementation of a carbon tax following the surprise election of a progressive political party) and changes in consumer behaviour (e.g. a shift in attitudes towards the purchase of plastics). These types of risk are all inherently uncertain in terms of both their impact and their time horizon. They may also be characterised by non-linear dynamics with high potential for positive feedback loops and covariance of risk probabilities (for example, a change in consumer behaviour might lead to a rapid shift in policy or vice versa) that standard statistical approaches are unable to deal with. Indeed, standard financial risk analysis is backward looking, usually based on less than five years of data observations and uses linear pricing techniques.
PUFFIN research will seek to examine the following kinds of questions to further this agenda:

- What examples from other fields are there of effective regulation that steers activity in a preferred (broad) direction under conditions of uncertainty?
- Can macroprudential tools be designed to ensure the type of systemic and non-linear/fat-tail type of financial risks posed by climate change are properly accounted for?
- What are the trade-offs between green macroprudential policy and other central bank policies, in particular microprudential policies and monetary policy?
- What lessons that can be learned from central banks and supervisors (such as the People’s Bank of China) who have already moved towards green macroprudential policy?

**Case study: Central Bank of Brazil**

Banco Central do Brazil (BCB) has been among the first central banks to issue regulation that addresses environmental and social risk on a systemic level and requires commercial banks to act accordingly in the process of assessing and calculating capital needs.

In July 2011, BCB issued a document, establishing procedures on commercial banks' Internal Capital Adequacy Assessment Process (ICAAP) and requiring them to take risk of exposure to environmental damages into account. ICAAP, a result of ‘Pillar’ 2 of Basel II accords, had been established in June 2011 and became a part of the mandatory banking regulation, requiring banks to assess the sufficiency of capital held by the institution.

Building on this, BCB requires banks to evaluate and consider risks to which the bank is exposed during the year, via stress testing, and to demonstrate, in the process of assessing its capital needs, that it has covered the risk arising from exposure to social and environmental damages, alongside other types of risk. BCB sets the general framework, listing the types of risks that banks have to take in to account when deciding themselves how much additional capital to hold after submitting its ICAAP for independent validation. Banks subject to ICAAP regulation are also required to submit an annual report to BCB, outlining how they assess and calculate risks, explore implications for capital adequacy and furthermore, to also consider the exposure to social and environmental damages generated by the institution's activities.

### 1.3.2 Green credit allocation

Green credit allocation policies would guide lending and investment towards prioritised zero-carbon sectors. Such measures could help develop missing green financial markets until they reach an appropriate scale.
The principle of controlling credit flows and interest rates to serve specific national interests was extensively applied in many Western countries after World War II57 58. Such practices were also key to the East Asian ‘economic miracle’ of the 1970s and 1980s and the more recent growth of the Chinese economy. There are various credit allocation policies that could be adapted to promote green investment59

- **Limits on brown lending or quotas for green lending:** Limits or quotas on the amount of commercial bank lending to particular sectors. This policy was very successful in promoting the development of the Japanese economy in the 1970s and 1980s60 by the Bank of Japan.

- **Green refinancing:** Green targeted refinancing lines that would allow commercial banks to borrow from the central bank at lower rates to ease financing constraints in green sectors and to encourage banks to lend for green purposes. By establishing these lines, central banks can encourage banks to lend more into green sectors by rewarding them with higher profits for doing so. The ECB’s refinancing lines encourage lending to non-financial businesses and households (except for mortgage lending61). Accordingly, the more banks lend to these entities, the more attractive the interest rate on their borrowings from the ECB becomes. While a framework would need to be devised to certify what constitutes as green loans, this programme could potentially be tweaked to offer cheaper rates for certain types of green lending — especially for green SME lending.

- **Green reserve requirements:** An alternative option would be for central banks to implement green reserve requirements. Reserve requirements are the share of deposits that commercial banks must be retained in central bank money. Higher or lower reserve requirements could be set depending on the ‘brown’ or ‘green’ nature of a commercial bank’s lending portfolio In practice, commercial banks would be allowed to hold fewer reserves when lending to a green cause and therefore increase the banks’ lending to this sector as a result of it being more profitable62.

Further research is needed to develop policy recommendations that are suited to today's context. Particular challenges with a modern-day version of credit guidance in advanced economies include a strong attachment to central bank independence and relatively ‘sectoral/market neutrality’; and secondly a more technologically sophisticated and globally mobile financial sector.
PUFFIN needs to convince public authorities that there are a wide variety of credit policy interventions that can be used to create a green direction for finance without compromising the credibility of central banks and financial supervisors. We will explore how central banks and ministries of finance and industrial policy can more effectively coordinate their activities in line with a cross-government green credit approach.

We will review existing examples of green credit guidance (including policies relating to both climate change and more general environmental protection) to try and understand how these are implemented and with what levels of success. Examples we will look at include policies in emerging markets such as China, India (see case study below) and Brazil as well as relevant historical examples in advanced economies and current advanced economy policies that have parallels with credit guidance, such as macroprudential policies.

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**Case study: Reserve Bank of India**

The Reserve Bank of India’s (RBI) Priority Sector Lending (PSL) programme has the objective of allocating credit to vulnerable sections of society. It is based on the Banking Regulations Act from 1949, which gives the RBI the legal ground to intervene in commercial banks’ lending practices and the allocation of credit. The PSL has traditionally focused on enabling access to finance for agriculture, infrastructure, education and Micro, Small and Medium Enterprises (MSMEs). Through different measures of banking regulation and guidelines, and by setting sector-specific interest credit quotas, the RBI ensures that 40% of commercial bank lending flows to priority sectors.

The current PSL includes eight categories, comprising of agriculture, MSMEs, export credit, education, housing social infrastructure and renewable energy. In regard to ‘renewable energy,’ a new category specifies bank loans not exceeding INR150 million (US$2.35 million) per borrower, used to finance projects for “solar based power generators, biomass based power generators, wind mills, micro-hydro plants and for non-conventional energy based public utilities viz. street lighting systems, and remote village electrification”, as credit that can be included in banks’ PSL loans. For individual household borrowers, the limit for eligible renewable energy loans has been set at INR1 million (US$15,600).
1.3.3 Greening central banks' balance sheets, or green quantitative easing

The considerable amount of assets currently being purchased by central banks via quantitative easing presents an excellent opportunity to re-channel financial flows more strategically towards greener, zero-carbon alternatives through what is often termed as green QE.

A green QE programme could take different forms. On the one hand, central banks could begin purchasing green bonds issued by corporates. Current QE programmes could be redesigned so that existing central bank money is strategically used to purchase green bonds.

Another possible approach is to purchase green bonds from development banks, green banks or similar public intermediaries such as the European Investment Bank, which will be discussed further below\textsuperscript{63 64 65}. These intermediaries could then finance lending for green infrastructure investments or green SME loans. Central banks might be more comfortable with this approach since the bonds would ultimately be underwritten by the state. Alternatively, in certain cases these public intermediaries could fund grants to support green public investment projects — in which case no private sector debt would be accumulated.

Targeting green QE in this way would provide considerable long-term demand for green bonds issued by corporates or public intermediaries. Caution in conducting such a programme would be warranted, as it could in principle contribute to mispricing of zero-carbon versus high-carbon assets, leading to a green bond bubble\textsuperscript{66}.

Further research is needed to understand:

- the underlying market structures and bottlenecks in funding zero-carbon investments;
- the extent to which the purchase of green bonds is an option for central banks, how much money could currently be absorbed through zero-carbon asset purchases, how such purchases would change the funding situation for green investments, and how to measure success; and
- what institutional set-up could underpin a green QE program, how to mitigate the risk of greenwashing, what role external rating agencies, research providers and auditors might play in that context, and whether for example the European Investment Bank could be a key pillar for such an initiative.
3. Meso finance and the climate crisis

Although central banks play a key macroeconomic role, they do not typically lend directly firms and other real economy actors. As a result, the structure of the financial system – the type of financial institutions and markets – has a material impact on the type of investments that are made. Finance is not neutral; the type of finance available can affect the type of activity that occurs. The type of finance that is provided depends heavily on its source, whether it is the private or the public sector and the multitude of different types of public and private financial actors.

Simply increasing the availability, and quantity of finance to green initiatives alone will not bring about the re-directed economy that we need. To re-orient growth towards in a green direction, what matters is not just the quantity of available finance, but the quality of finance.

The European Commission has recognised that new technologies, sustainable solutions and disruptive innovation will be critical to achieve the objectives of the European Green Deal. But because innovation is highly uncertain, has long lead times, is collective and cumulative, it requires a specific type of finance. Uncertainty means that finance must be willing to bear high risks; the long-run nature of innovation and its cumulativeness imply that the kind of finance must be patient. A three to five year investment cycle does not match the increasingly long lifespan of a wind turbine array or of the innovation needed in e-mobility, natural capital development (such as rewilding programmes) or green infrastructure projects.

Short-termism and risk-aversion means that the private sector will often not invest in higher-risk areas until future returns become more certain. For this reason, public sectors have historically supplied the patient strategic finance that the private sector was unwilling to provide for high-risk projects. From advances such as the internet and microchips to biotechnology and nanotechnology, many major technological breakthroughs — in both basic research and downstream commercialisation — were only made possible by direct public financing. In each of these areas the private sector only entered much later, piggybacking on the technological advances made possible by public funds.

In these cases, the state has not just sought to fix market failures but has acted boldly to create and shape new markets and landscapes. This takes different institutional forms, including public research and development (R&D) funds, innovation agencies, sovereign wealth funds, development finance institutions and public venture capital funds and more. But in many countries, this kind of patient strategic finance is increasingly coming from state investment banks (SIBs), or development banks.
1.4 State investment banks and the green transition

SIBs have long played a key role financing and directing investment in many countries around the world. Their fundamental role is to promote public policy objectives by influencing the volume and direction of investment in the economy. Because the governance arrangements of SI Bs typically do not create pressure to deliver short-term returns, they can provide patient financing over a longer time horizon, prioritise wider social and environmental objectives, and take a different approach to risk and reward.

Modern SI Bs have their historical roots in the reconstruction plans for Europe following the Second World War. The aim was to create institutions that promoted financial stability through a flow of patient finance to fund the post-war reconstruction, and avoid the destabilising effects that speculative private finance could have on the economic recovery.\textsuperscript{24} In subsequent decades, many regional, national, or subnational SI Bs were created, with a diverse set of operational focus and roles.\textsuperscript{25}

In Europe, many countries have their own national SI Bs (which are often referred to as ‘National Promotional Banks’), as well as being members of the European Investment Bank, the European Union’s own SI B. In 2019 the European Investment Bank announced that it will end financing for fossil fuel energy projects from the end of 2021, and will align all financing activities with the goals of the Paris Agreement – thus becoming Europe’s ‘climate bank’.\textsuperscript{26} The European Commission’s Green Deal, published in December 2019, also recognises that the European Investment Bank and national promotional banks have a key role to play in financing Europe’s green transition.

While these are noble aims, much remains to be done to ensure that the missions, mandates, policies and activities of these institutions are aligned with these ambitions.

1.5 From market fixing to market shaping: how state investment banks can support a zero-carbon transition

The institutional design of SI Bs varies significantly between countries, and their investment activities have evolved over time in line with country-specific developments and challenges, as well as the wider institutional landscapes. While the traditional functions of SI Bs have been in infrastructure investment and counter-cyclical lending, in recent times some have taken on more active roles as key agents of industrial and innovation policy.

Internationally, there is mounting evidence that patient finance for bold ‘mission-oriented’ investments have come from SI Bs, and in countries such as Germany and China SI Bs have taken centre stage financing the green transition.\textsuperscript{77, 78, 79, 80}
Understanding how this can be accelerated and scaled up – what works, what does not – is a key aim of the PUFFIN project.

In the next section, we explore different institutional characteristics that may impact a SIB’s capacity to finance green innovation, drawing on existing IIIP research. As part of the PUFFIN project we will be undertaking in-depth qualitative research in partnership with a consortia of SIBs to explore these characteristics in more depth and identify key lessons that can be applied to better align SIBs with climate objectives.

1.5.1 Mandates

The overarching mandate is critical to the role that SIBs play in their economies. The conventional view in economics is that SIBs should focus their activities on fixing ‘market failures’. Market failures are ‘imperfections’ in the price system that prevent markets from efficiently allocating resources. Typical examples include credit rationing and high return requirements due to banks’ high transaction costs for identifying viable investment projects (e.g. in the SME sector), and underinvestment in areas such as research and development, infrastructure, education and environmental projects.

This ‘gap filling’ mandate is also endorsed by the European Commission in its advice on setting up new national promotional banks. However, while a market failure mandate may be useful in certain circumstances, evidence suggests that this is primarily where SIBs are aiming to support existing techno-economic trajectories. It is less useful in so far as there is a need to urgently create and shape new techno-economic trajectories and overcome key societal challenges, as in the case of the climate crisis. This is because markets are ‘blind’ — that is, incapable of providing a new, qualitatively different direction to economic development. Fixing market failures may influence the rate of change, not the direction of change. A market failure focused mandate is therefore unlikely generate the kind of transformative, catalytic, mission-oriented public investments that in the past created new technologies and sectors which did not exist before.

Our research has shown that SIBs that are ‘mission driven’, with mandates guided by specific missions aligned with key societal challenges, can be more effective than those which are focused on simply fixing market failures. By steering the path of innovation towards overcoming key challenges, a mission-oriented mandate in turn helps to catalyse investments in areas for which markets do not yet exist, as is common with other mission-oriented agencies. This market creating and shaping role helps to create new technological and industrial landscapes, catalysing activity that otherwise would not take place. By focusing finance on missions that need cross-sectoral collaborations, public institutions are less open to capture by specific business interests, and less susceptible to the related ‘picking winners problem’.
Further research and testing is required to determine how mission-oriented mandates can be most effectively designed, implemented and evaluated. One area that will be explored further in the PUFFIN project is how the definition of green missions can be opened up to a wider group of stakeholders, including green movements and civil society. Understanding more democratic processes through which missions are defined and targeted is important to build legitimacy and buy-in from the public. It may also help ensure that ambitious policies – daring to reimagine the market rather than just fixing market failures – are less likely to meet resistance and be accused of ‘crowding out’ private activity. Establishing new ways of involving wider stakeholders in the definition of missions, as well as the process of how to achieve them, will be an important area of future work.

**Case study: Scottish National Investment Bank**

In September 2017, the First Minister of Scotland Nicola Sturgeon announced plans to establish a new Scottish National Investment Bank to support the Scottish Government’s vision for delivering smart and inclusive growth. The announcement was informed in part by advice from IIIP Director Professor Mariana Mazzucato, who has been part of the Scottish Government’s Council of Economic Advisors since 2016.

Following the announcement, IIIP was appointed to a small Advisory Group that was convened to lead the work developing an evidence-based implementation plan. The implementation plan was published in February 2018, and draws on IIIP’s research to outline a roadmap for creating a new mission-oriented Scottish National Investment Bank. The proposed vision for the bank outlined in the plan is:

‘The Scottish National Investment Bank will provide finance and act to catalyse private investment to achieve a step change in growth for the Scottish economy by powering innovation and accelerating the move to a low-carbon, high-tech, connected, globally competitive and inclusive economy.’

In March 2019, IIIP published a new report outlining a mission-oriented framework for the Bank which, if implemented successfully, will maximise its potential for promoting transformational change across Scotland’s economy. Drawing on international evidence, as well as IIIP’s own path-breaking research, we set out clear criteria for designing missions, as well as how a mission-based approach should be implemented in practice.

The bank is expected to become operational in 2020, and will aim to maximise additionality by providing access to the long-term patient finance necessary for ambitious firms to invest in innovation, and for large-scale projects that will help transform Scotland’s economy in line with the bank’s missions.
1.5.2 Investment logic

As noted above, the investment logic deployed by SIBs and other PSFIs is typically focused on correcting ‘market failures’. However, the climate crisis cannot be by fixing existing markets — instead there is an urgent need to create new markets, technologies and industrial landscapes. Catalysing this kind of structural transformation requires a different investment logic, as has been recognised by EIT Climate-KIC’s ‘transformation capital’ initiative.88

In contrast to the market fixing logic, a market-shaping, mission-oriented approach to investment is concerned with co-creating and shaping markets to achieve societally agreed missions driven by public purpose, rather than limited to ‘market fixing’.89 This approach views markets themselves as embedded in society and hence as outcomes of the interactions between the public, private and civil society sectors.

Table 1: Market-fixing vs. Market-shaping analytical frameworks

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<th>Market fixing</th>
<th>Market shaping</th>
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| **Justification for the role of government** | Market or coordination failures:  
  - Public goods  
  - Negative externalities  
  - Imperfect competition/information | All markets and institutions are co-created by public, private and third sectors. Role of government is to ensure markets support public purpose, also by involving users in co-creation of policy |
| **Business case appraisal** | Ex-ante cost benefit analysis (CBA) – allocative efficiency  
  assuming static general relationships, prices etc. | Focused on systemic change to achieve mission-dynamic efficiency (including innovation, spillover effects and systemic change) |
| **Underlying assumptions** | Possible to estimate reliable future value using discounting. System is characterised by equilibrium behaviour | Future is uncertain because of potential for novelty and structural change; system is characterised by complex behaviour |
| **Evaluation** | Focus on whether specific policy solves market failure and whether government failure avoided (Pareto efficient) | Ongoing and reflexive evaluation of whether system is moving in direction of mission via achievement of intermediate milestones and user engagement. Focus on portfolio of policies and interventions, and their interaction |
| **Approach to risk** | Highly risk averse; optimism bias assumed | Failure is accepted and encouraged as a learning device |

Source: Kattel al (2018)90
Mission-oriented investments catalyse structural economic change across multiple sectors, and stimulate multiple forms of cross-actor collaborations to work to address those problems using the entire innovation value chain, from fundamental research to applied research and cutting-edge innovative firms. They can also generate difficult-to-predict spillover effects outside the primary investment objective.

As part of the PUFFIN project we will work with partners to explore:

- how a market-shaping, mission-oriented investment logic can be most effectively operationalised and embedded into the institutional fabric of PSFs;
- what policy barriers are preventing PSFs from embracing a market shaping, mission-oriented investment logic; and
- how the broader policy landscape (e.g. regulation, taxation, state aid criteria, procurement rules, etc.) could be modified to encourage mission-oriented investment logic.

1.5.3 Funding instruments

Different types of investment activity require different types of finance. Having different funding instruments available is important to manage the balance of risk and reward effectively across a portfolio, and to best match the optimal finance for different types of projects. For example, equity investments may be suitable for higher risk projects, while debt instruments such as long-term loans may be better for lower-risk, incremental activities. Having a wide range of instruments available enables investments to be made across the business lifecycle, from the start-up phase all the way through to providing long-term patient capital for established firms.91

In addition to lending operations, there is strong evidence that offering advisory services such as strategic planning, capacity building, and training programs can help to establish bankable projects that otherwise would not happen.

In establishing a product offering, it is important that SIBs are able to strike the right balance between risks and rewards, ensuring that investments are structured across a risk-return spectrum so that lower risk investments help to cover higher risk ones. Where success occurs, there is a strong case that the public sector should be able to reap some of the financial rewards in that have resulted from its risk-taking order to offset the inevitable failures.

Some SIBs, such as the European Investment Bank, have devised bespoke risk-reward sharing mechanisms for investments in innovative areas like drug development (see case study), although as of yet none have been developed to support green innovation.
As part of the PUFFIN project we will work with partners to explore:

- which instruments are most conducive to financing green innovation, and whether there is a need to develop new tailored instruments;
- how reward sharing mechanisms can help create a new symbiotic type of public-private partnership for meeting climate objectives;
- whether attaching conditions to financial instruments (e.g. conditions regarding profits being reinvested, carbon footprint, etc) can be an effective way to drive behavioural change across the economy; and
- the extent to which advisory services such as strategic planning, capacity building, and training programs can help drive green innovation.
Case study: European Investment Bank

The European Investment Bank (EIB) is the financing institution of the European Union. The EIB offers a range of instruments including senior loans, junior or subordinated loans, intermediated loans / credit lines, equity funding and guarantees. The EIB also makes extensive use of equity finance to capture the upside from supporting innovative firms, mainly through its majority shareholding in the European Investment Fund (EIF) which facilitates access to equity for high-growth and innovative SMEs.

In recent years the EIB has also entered into a number of loan agreements with innovative companies which involve bespoke risk-reward sharing mechanisms. In 2014, the EIB put €75 million towards six drug development projects with Belgian biopharmaceutical company UCB to put up as part of a new ‘at risk co-development funding’ scheme set up under Horizon 2020 to finance R&D projects across Europe. The scheme means that the EIB shares the risks and potential rewards inherent to drug development. The EIB invested directly in UCB’s R&D expenditures relating to specified R&D programmes and over a specified time frame. Through this investment, the EIB acquired and co-owned (with UCB) part of the intellectual property (IP) that would be jointly developed under the specified programme during the specified time frame. UCB was required to make payments to the EIB if and when predefined milestones were successfully achieved, for example if a pre-specified programme met its clinical endpoint or regulatory approval was obtained. At the end of the partnership, UCB will ultimately re-acquire all the co-owned IP.

In 2017, the EIB provided €75 million to Evotec to invest in research and development of treatments for serious illnesses. The loan is guaranteed by the European Fund for Strategic Investments (EFSI), the central element of the Investment Plan for Europe, the so-called Juncker Plan. The EIB funding supports Evotec’s Innovate strategy through a unique, innovative and flexible financing structure including a “moderate reward-sharing component” for the EIB. The €75 million total loan financing will be invested into R&D over a period of four years and will mature seven years after draw down. The transaction is the first large success-sharing investment under EFSI in any industry anywhere in Europe, and represents EFSI’s first contingent investment, whereupon the bank shares the risk of its client’s research & development (R&D) success.

1.5.4 Governance

Governance arrangements are particularly important for public financial institutions. On the one hand, it is their distinct governance structures of that enable them to play a fundamentally different role in the economy compared to that of private financial institutions. These governance arrangements typically do not create pressure to deliver short-term returns, meaning that they can provide patient financing over a longer time horizon and prioritise wider social and environmental objectives.

On the other hand, many of the problems that have commonly been associated with SIBs, such as weak performance, financial problems, unfair competition with
the private sector, capture by interest groups, can be attributed to poor governance. Experience shows that it is important that management teams are free of day-to-day political interference to make independent, long-term decisions; such capacity for autonomous decision-making has historically been key for successful ‘innovation bureaucracies’.

As part of the PUFFIN project we will work with partners to explore:

- how public sector financial institutions can strike the right balance between political representation and independent decision making when designing governance structures to support green missions;
- the extent to which stakeholder representation (for example from green movements and civil society) in governance structures can help to build legitimacy and buy-in from the public; and
- how undue political interference and capture by interest groups can be avoided.

### 1.5.5 Capacity and expertise

A key difference between some of the most successful public financial institutions and private financial institutions is the breadth of expertise contained within staff. In many cases this includes not only financial expertise but significant in-house engineering and scientific knowledge about the sectors the bank is active in. This allows these institutions to base investment decisions on a wider set of criteria, and are better placed to appraise social and environmental considerations. This is particularly important for green investments, which are often by nature risky and uncertain, and market signals are less reliable.

There is also evidence that significant in-house expertise can also enhance the ability to crowd-in private investment by acting as a ‘hallmark' of quality which gives private investors the confidence to co-invest.

As part of the PUFFIN project we will work with partners to explore the kind of capacities and capabilities that will help public financial institutions identify, appraise and monitor the kind of dynamic, catalytic investments that can fuel green innovation.

Here lessons can be learned from mission-oriented organisations like DARPA and ARPA-E in the US, Yozma in Israel, SITRA in Finland and Vinnova in Sweden. Evidence shows that talent in these organisations is key – staff typically have a clear understanding of the nature of the investments being made, and a willingness to engage in ‘big thinking’. The point is not to copy these organisations but to learn from key sources of their success. For example, these organisations have explicitly welcomed risk-taking at the organisational level; they have used secondment
practices to bring high-level scientists into the civil service for limited time periods; they have often aligned goals with national procurement practices; and have been extremely good at drawing on expertise of wider networks.

Such organisations develop what has been called ‘mission mystique’ or institutional charisma: it is an honour to work in a mission-oriented organisation where ambitions for the use of innovation to solve problems are as important as building in-house capacity and expertise.\textsuperscript{94}

1.5.6 Sources of finance

There are many different ways that SIBs finance their operations, including taking savings and deposits from the public, raising funds in the domestic or international capital markets, borrowing from other financial institutions, using return on investments, receiving budget allocations from the national treasury, managing public pension or social security funds, or receiving financing from the central bank. There is evidence that sources of finance can have an impact on the ability of public financial institutions to successfully meet their mandates (see case study) If a source of finance proves to be volatile or unstable, then this can impair the ability to successfully fulfil a mission-oriented mandate. Another important consideration is whether different sources of finance affect a bank’s appetite for risk, which is particularly important for the financing of green investments.\textsuperscript{95}

A key focus of the PUFFIN project will be to explore which sources of finance are most conducive to financing green innovation. One possible hypothesis is that sources which draw heavily on government budgets or household savings create political pressure to minimise risk taking and thus reduce investment in innovation. Another area we will explore in the PUFFIN project is the potential for greater coordination between central banks and SIBs, in particular given central banks’ much larger current balance sheets following the financial crisis of 2007-08. Central bank financing of SIBs was common across a wider range of countries in the post-war period.\textsuperscript{96} As part of the PUFFIN project we will explore whether greater collaboration between macro and meso level PSFIs could help accelerate the climate transition.\textsuperscript{97}
Case study: Brazil’s BNDES

Banco Nacional de Desenvolvimento Econômico e Social (BNDES) is a Brazilian bank founded in 1952 to finance the construction of key infrastructure projects, expand industry and assist with the mechanisation of agriculture in Brazil. Although initially established to finance Brazil’s catch-up strategies, over the course of the bank’s history its operations have evolved in line with the Brazil’s socio-economic challenges. BNDES’ activities now include support for exports, technological innovation, sustainable socio-environmental development and the modernization of public administration. In recent decades, BNDES has had a catalytic role in promoting transformational investments in different phases of Brazil’s development.

Until recently BNDES’ main sources of funding were two “quasi-public” funds (known as the PIS-PASEP and the FAT) which are associated with social insurance and workers’ safety nets. Small amounts of funding also came from returns of its outstanding loans and equity investments, as well as international borrowing, mainly from multilateral institutions.

However, the composition of BNDES’ funding has changed dramatically since 2009 after the bank significantly increased disbursements in order to counteract the retrenchment of private financing that followed the Global Financial Crisis. Because BNDES was unable to borrow from capital markets at a pace compatible with the expansion of its loan portfolio, funding became highly dependent on transfers from the National Treasury, which increased from below 10% of total liabilities to more than 50% of the total.

After the impeachment of former president Dilma Rousseff in July 2016, a new government was formed which appointed a new leadership team at BNDES and implemented a new strategy. BNDES was asked to make an unanticipated repayment of the money it had borrowed from the National Treasury, starting with a payment of R$ 100 billion (US$ 30 billion) in December 2016. This transfer, which comprised of R$40 billion in securities and R$ 60 billion in cash, was justified by a political desire to reduce Brazil’s overall national debt. This early payment was equivalent to 19% of the total amount that BNDES owes the Treasury, and over 120% of the bank’s disbursements in 2016. This lack of stable, low-cost funding has meant that the bank has had to constrain its activities in recent years, which has further undermined its ability to play a dynamic mission-oriented role.

1.5.7 Relationship with government policy and the innovation ecosystem

Successful innovation is not the product of any single body or agency, but rather of the interactions between different agencies across the entire innovation chain, which in turn interact with private actors. In other words, the wider innovation ecosystem is important.98 Without a systemic and aligned approach involving institutions in both private and public sector, simply increasing the availability of finance will not be sufficient.
Evidence suggests that close alignment between SIBs and government policy can create a powerful synergy between policy, regulation and financing, which can be coordinated for maximum impact. For example, new government policies can be complemented with new financing instruments or financial regulations in order to transmit policy objectives more efficiently. Although potentially powerful, this relationship is highly dependent on effective governance arrangements to ensure that sound banking principles are maintained and undue political interference is avoided.

In the PUFFIN project we will work with partners to explore how public sector financial institution can most effectively interact with national and supranational government policy and the broader innovation ecosystem to support climate objectives.

**Case study: KfW and Germany’s Energiewende policy**

KfW is a German public bank based in Frankfurt. Its name originally comes from Kreditanstalt für Wiederaufbau (‘Reconstruction Credit Institute’) and was established in 1948 after the Second World War as part of the ‘Marshall Plan’ to support post-war reconstruction. Since then the development of KfW Group has been closely connected to the economic development of the Federal Republic of Germany. Today its activities include SME support, export promotion, environmental protection, innovation and international development.

KfW is tasked with implementing policy objectives of the German government, and receives the full backing of the German government to do so. However, the KfW is not just a passive public body, it also participates in policy development. The KfW regularly assists the government in selecting targeted policy areas and designing projects as well as financing them, and is highly valued for its financial and sectoral expertise. This close operational relationship between the KfW and the German government creates a powerful synergy which means that policy, regulation and financing can be simultaneously coordinated for maximal societal benefit impact.

An example of this has been the KfW’s instrumental role in the German government’s Energiewende policy (‘energy transition’). By financing both the supply side (through the support of green technology firms) and the demand side (through the financing of solar and wind power) the KfW has been a key driving force behind Germany’s economic transformation towards a green economy.
1.5.8 Monitoring and evaluation

Whereas private financial institutions tend to be evaluated on the basis of their financial performance, SIBs and other PSFIs are often evaluated on the extent to which they are fixing perceived market failures. As noted above, it is common for SIBs to be criticised on the basis of “picking winners”, crowding out or funding large incumbent companies. While there may be some instances where criticism is merited, part of the reason may also lie in the absence of monitoring and evaluation frameworks which adequately capture the additionality generated by bold mission-oriented investments (i.e. even if the original objective is not reached, an investment might still be considered to be if it catalysed positive, economy-wide spillover effects).

Where the aim of investments is not to fix market failures but to create and shape new markets and technologies, new monitoring and evaluation frameworks may be required in order to accurately assess the performance of investments made by SIBs and other PSFIs.

As part of the PUFFIN project we will work with partners to explore:

- whether new metrics of appraisal are required to adequately monitor and evaluate the performance of market-shaping, mission-oriented investments;
- how cross-sectoral impact and dynamic spillovers that result from green innovations can be assessed and measured; and
- how innovations in real time data can be used to monitor progress on investment milestones.
4. Micro finance and the climate crisis

In order to steer finance in the right direction, it is important to understand what is being financed at the present time (and by whom), as well as the determinants of these decisions so as to be able to influence them with public policy.

On the first of these, the focus on achieving a greater amount of finance has diverted attention from what is being financed. Since finance flows towards concrete projects and firms, finance always — unless distributed uniformly — creates a direction towards areas and technologies that these organisations promote. This may result in a skewed distribution of investment low-carbon projects, so that some areas are over-financed, while others are under-financed. The lack of attention on the relationship between finance and directionality is surprising, because it is widely recognized that a diverse set of low-carbon technologies is desirable, for at least two reasons. Firstly, with a wide portfolio, if innovation is unsuccessful in one area, not all eggs are in one basket, and a diversified low-carbon technology landscape increases resilience of the new production system.\textsuperscript{101}

Second, it is important to understand what institutions are financing or are in principle able to finance the various types of low-carbon projects so that the distribution can be influenced. Since most finance ultimately hits ‘downstream’ deployment of large projects, and since the effects of increasing returns to scale and learning by doing create path dependencies, patterns of downstream investment are particularly important to understand.\textsuperscript{102}

In renewable electricity supply technologies, research has shown that financial actors vary considerably in the composition of their investment portfolio, creating directions towards particular technologies. Public financial actors invest in portfolios with higher risk technologies, also creating a direction; they also increased their share in total investment dramatically over time. However, more work remains to be done especially on what determines where private investors put their money.

1.6 Determinants of investment

There is a long line of research proposing different policy mechanisms that may help bring about low-carbon technologies, yet current debate is mostly focused around passive revenue subsidies, realised through feed-in tariffs and/or tax rebates that are applied indiscriminately to any asset fulfilling certain criteria, such as renewable energy generation with a certain technology range, or road transport vehicles using an electric motor. While these subsidies tend to be in place in one form or another in most countries\textsuperscript{103}, the result so far is only the insufficient amount of investment observed above, and the question arises whether more attention has to be given to more discretionary, pro-active policies.
Studies that have examined the renewable electricity sector have found that direct government investment and co-investment has had some of the strongest effects of mobilising private co- and follow up investment, and that specialised agencies including green investment banks have played a key role in mobilising private finance.\textsuperscript{104} There is also evidence that in previous rapid and directed energy transitions, direct state investment played a major role.\textsuperscript{105}

Whilst this research represents a good starting point, and some additional evidence is available for other sectors\textsuperscript{106}, further research is required to establish:

- how direct public investments can be most effectively designed to crowd-in additional private investment at the firm level of individual and follow up projects;
- how public financing interacts with other policy instruments to affect the quantity and quality of private investments; and
- whether the design features of different public actors, such as state investment banks, can affect their potential ability to mobilise additional private capital at the micro level.
Case study: Direction setting in Iceland

In the second half of the 20th century, Iceland transformed its economy from being reliant on coal and later gas to mainly using geothermal energy. While geothermal accounted for a negligible share of energy before 1930, it is now responsible for two-thirds of Iceland’s primary energy supply, with another 20 per cent coming from hydro power, making the transition from less than 5 per cent in the mid-1930s to above 50 per cent in 1980. Although the use of geothermal energy for driving steam engines was discussed as early as the mid-19th century, drilling to systematically tap the heat only began in 1928. This was followed by a remarkable increase in geothermal energy for heating and, by the mid-1980s, some 80 per cent of Iceland’s buildings were heated by geothermal energy. Conversely, this transition reduced coal to a single-digit percentage of primary energy use by 1955, and a drop in oil from a peak share of 59 per cent in 1959 to less than 20 per cent since 2007.

Up until the mid-1980s, all of Iceland’s geothermal energy was publicly financed, costing $1.2 billion (in 1992 dollars) between 1973 and 1992. All geothermal field developments were financed and carried out by the Geothermal Division of Iceland’s National Energy Authority. Where necessary, R&D was carried out in collaboration with the University of Iceland. Meanwhile, the State Drilling Company, established in 1945, was responsible for drilling the holes to tap the heat, and municipalities financed, owned and operated the district heating systems. Geothermal electricity technology was developed in the 1960s by the State Electricity Authority with a first set of plants built in 1969–72. Private actors only entered this picture in 1986, when the State Drilling Company issued shares. This company became effectively privately controlled in 1992, as the government shed its remaining shares. By that time, part of the R&D was also outsourced to private companies. Nevertheless, utilities remain in municipal ownership today, and the government continues playing a central role in financing both research and investment in power plants.

1.7 Scoping data beyond renewable electricity supply

The low-carbon transition is not limited to the energy supply sector. The question of investment mobilisation stretches across the economy, for instance in energy intensive sectors such as cement or steel. A crucial limitation can be data availability for quantitative research on this question.

As part of the PUFFIN project we will investigate the extent to which the kind of database we have for renewable energy can also replicated for other sectors and their assets. Recent research shows the feasibility of verifying the existence of such assets at the micro level for steel, cement, automobiles, airlines, and shipping, and other climate-relevant sectors. Whilst this research is cutting-edge research in asset identification and characterisation (i.e. the asset’s emissions), little attempt has been made to trace investments and their origin. We know of no research in the public domain that attempts to understand either asset-level ownership/investment patterns or how public investment affect these. Therefore, data scoping in
this area will be important to make progress and understand similarities and differences between sectors.
5. Conclusion and next steps

The transition to a zero-carbon economy compatible with the Paris Climate Change agreement will require a vast mobilisation of resources. Whilst efforts to green capital markets are important in financing such a transition, they are far less likely to be successful unless PSFIs are also aligned with climate targets.

Although some PSFIs have taken tentative steps to incorporate climate change into their operations, there remains little consensus about what PSFIs should be doing to support the zero carbon transition. In this paper we have introduced the macro-meso-micro framework, and set out some of the key questions that must be addressed if the missions, mandates, policies and activities of PSFIs are to be aligned with climate objectives. In order to answer these questions, the PUFFIN project will be organised around three distinct phases.

In phase one, which is already underway, we will focus on identifying the key barriers that are preventing PSFIs from aligning with climate objectives. We will do this by undertaking original desk research, and by building strong relationships with our key PSFI partners at macro, meso and micro level. This will involve bilateral meetings and interviews with the partners in our consortia, as well as ideation workshops that bring our partners together to identify shared issues and diagnose common barriers. Our findings will be documented in a report that will be published in September 2020.

In phase two of the project we will use these insights to collaboratively explore how the missions, mandates, policies, instruments and activities of PSFIs could be redesigned to better support green innovation and accelerate the zero carbon transition. We will do this interactively with partners by running in-depth mandate and mission labs with our consortia to challenge PSFI mandates, mainstream market-shaping approaches, and help build capacity within partner organisations. Our findings will be documented in a series of reports published throughout 2021.

In phase three of the project we will develop concrete and implementable policy recommendations at each level of the ecosystem (macro, meso and micro), and work with partners to test and refine these innovations, including in specialist PSFI ‘sub-forces’.

To ensure that recommendations are not made in a vacuum from real economy green actors, we will establish Real Economy Problem Owner Task Forces that will bring together PSFI and real economy actors from along the finance chain to tackle the barriers identified earlier phases. These Task Forces will include green innovation company representatives and green movement advocates, as well as policy-makers in industrial and environmental strategy at local level, such as local government.
To conclude the project, we will develop detailed recommendations for how the missions, mandates, policies, instruments and activities of PSFIs should be redesigned to better support green innovation and accelerate the zero carbon transition, and publish comprehensive implementation roadmaps to enable PSFIs to put our recommendations into practice.
Appendix 1: Further reading – extracts from supporting papers

**Patient Strategic Finance: opportunities for state investment banks in the UK**

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**Laurie Macfarlane**
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(Extract from p.1)

The return of industrial policy to the political mainstream provides an opportunity to forge a new path. By making strategic investments and nurturing new industrial landscapes, a modern industrial strategy focused on solving important societal challenges can help to rebalance the economy and reinvigorate the industrial base. A 'mission-oriented' approach to industrial policy can help to determine the direction of growth by making strategic investments across many different sectors, and improving business expectations about future growth areas. This requires not just any type of finance but patient, long-term, committed finance. This can take different forms, but in many countries, patient strategic finance is increasingly coming from state investment banks (SiBs). By developing new financial tools and working closely with public and private stakeholders, state investment banks can – if structured effectively – play a leading role driving growth and innovation.


**Financing green growth**

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(Extract from p. 1)

Transitioning to a green economy requires both public and private investments. Given the long-lead times and high uncertainty in innovation, such investments must involve patience and welcome risk. The challenge is significant: requiring transformational “public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services” (UNEP 2011, p. 2). How to finance these high-risk and long-term investments in green real assets is the problem of financing green growth. The quantity of finance is as important as the quality. Currently, the rate of green investments is too low for green growth to take off (OECD 2015a; IEA & IRENA 2017), and often too impatient (HLEG 2018). To avoid dangerous
global warming, investments in low-carbon technology must increase quickly: time is of the essence (Stern 2015, Sgouridis et al. 2016).

Although the low-carbon transition is not just about low-carbon energy but also about reducing energy intensity across the economy, we use the case of decarbonising the energy sector to illustrate the magnitude of the challenge. Table 1 compares recent global investment trends in low-carbon energy sources with projected ones in the next two decades, which are necessary to achieve cumulative carbon emissions consistent with a 2 [degrees] Celsius average global warming. While definitions of the clean energy sector and projected investments differ between the three projections, they all emphasise the need for investments to double or even triple over the next 15 to 25 years (rows 1 and 2). This implies compound annual growth rates that are several percentage points higher than recent historical rates (rows 3 and 4). Clearly, current trends in investment are insufficient, and the question is where the funds required for financing the groundswell in investment would come from.


Bringing the helicopter to ground

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Frank van Lerven
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(Extract from p. 24)

Although public and development banks are commonplace today, very few of them are funded by central banks or have the power to autonomously create credit in the way commercial banks do. Rather, their initial capital normally comes from ministries of finance and their lending is limited by the funds they can raise via bond issuance on capital markets. Many development banks also intermediate and leverage existing savings, grants or loans from international organisations, for example the World Bank. They might thus better be described as ‘funds’ than banks. This is not to say they do not have important economic impacts. . . .

Historically, however, central banks have often played an important role in the economic and industrial development of economies and this has included the setting up and capitalising of state investment banks (SIBs), as the example of Canada, below, demonstrates.


Credit where it’s due: A historical, theoretical and empirical review of credit guidance policies in the 20th century.

Dirk Bezemer
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How should policy respond to the ‘debt shift’ that has occurred in advanced economies since the 1990s, whereby the majority of bank credit no longer supports non-financial firms, but instead is allocated towards the purchase of existing real estate and financial assets? One option is to consider credit guidance policies that aim to steer bank credit creation and allocation towards desirable sectors of the economy and to repress less desirable lending. To be clear, this is not to advocate short-term political interference in credit markets in pursuit of votes or in support of special interests. Given the abundant evidence on the adverse macroeconomic effects of excess mortgage credit in particular, ‘desirable’ here simply means ‘improving growth and stability outcomes’. The evidence in this paper suggests that if credit allocation is left to the market, this is unlikely to occur.

The theoretical case for credit guidance is strong. Bank lending is key to economic growth, but, given conditions of uncertainty, is equally prone to the creation of financial bubbles and crisis, as recognised by Schumpeter, Keynes and Minsky, and more recently by a range of empirical studies. Individual banks are not equipped nor incentivised to consider the macroeconomic consequences of their own choices. Instead, they tend, if freed from regulation and guidance, towards collateral-oriented credit rationing, which produces sub-optimally high levels of credit for real estate and the financial sector, and not enough credit for productivity-enhancing investments in the real sector. This leads to lower levels of investment and innovation, to asset price bubbles (including house price bubbles) and to unsustainable household debt-to-income levels.

https://www.ucl.ac.uk/bartlett/public-purpose/publications/2018/nov/credit-where-its-due

Neither crowding in nor out: Public direct investment mobilising private investment into renewable electricity projects

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(Extract from p.1)
Insufficient investment into low-carbon technologies is emerging as one of the key pivots in mitigating climate change. In the energy sector, models in the new Intergovernmental Panel on Climate Change (IPCC) 1.5°C report suggest aggregate annual energy supply investments may have to be 50% higher in 2016 to 2050 compared to current levels, to meet the Paris Agreement targets (IPCC 2018, p. 18). In addition, the direction of investments has to radically shift towards low-carbon energy (across the energy supply, not just in power), with gross investments into low-carbon sources to overtake that into fossil fuels as soon as 2020 (McCollum et al. 2018, Figure 5). These developments require a large uptick in low-carbon energy supply investments (Semieniuk and Mazzucato 2019). In addition, IPCC projections rely on optimistic forecasts about low future energy demand (Loftus et al. 2015; Semieniuk 2018; Semieniuk et al. 2019), so the investment estimates can be considered conservative.

In contrast with such projections, actual global investment into low-carbon energy supply has stayed roughly constant since 2011 (IEA 2018) and investments into renewable electricity technologies (RETs), an important subset of low-carbon energy supply, have been stagnant since 2015 (UNEP & Bloomberg New Energy Finance 2018). It is widely recognised, first, that private funds must finance most of these investments and, second, that radical mitigation policies must be implemented to realise such a tremendous private investment upsurge, which implies a simultaneous redirection of private investments from high- to low-carbon technologies. The level or type of policy deployed so far has not achieved this. For instance, in spite of an increasing number of policy measures deployed, recent investments from private sources into RETs did not climb above pre-Great Recession levels of 2008 (Mazzucato and Semieniuk 2018). This raises a question about what type of policy had what effect in the past on private investment. If policy is to become more radical, it is important to understand what has worked so far.

https://www.ucl.ac.uk/bartlett/public-purpose/publications/2019/oct/neither-crowding-nor-out

Climate-related financial policy in a world of radical uncertainty

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(Extract from p.24)

In this paper we have proposed the adoption of a Precautionary Financial Policy (PFP) approach to deal with the financial stability risks created by climate change. This approach is justified because CRFR, both transition and physical, are characterised by radical uncertainty, meaning conventional backwards-looking probabilistic financial risk modelling is not fit for purpose in dealing with them. While scenario analysis and stress testing to some extent recognise the uncertainty problem, they remain based upon assumptions that are subject to significant uncertainty and do not sufficiently justify action in the short term, despite widespread recognition of the risks posed by inaction.

… and continuing on …
This paper is an exploration and attempt to lay out a new policy framework for dealing with CRFR rather than a turn-key solution for financial regulation in the face of such risks. Future streams of research would involve deeper analyses of the possible tools and policies that can be activated, which we have discussed only at a high level in this paper. In parallel, objective evaluations of which CRFR challenges are priorities in terms of (further) data and modelling effort, aiming to establish appropriate policy actions for each time horizon considered, i.e. distinguishing the level of knowledge that can be expected in six months, one year, three years, ten years, etc. and those policy actions that, since they address challenges that will remain subject to radical uncertainty, can be taken much sooner.


A mission-oriented framework for the Scottish National Investment Bank

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(Extract from p.18)

Short-termism and risk-aversion means that the private sector will often not invest in higher-risk areas until future returns become more certain. This is why across the world the early stages of the innovation chain are disproportionately occupied by public sector actors. Early stage public investment helps to create and shape new markets, nurturing new landscapes which the private sector can develop further. From advances such as the internet and microchips to biotechnology and nanotechnology, many major technological breakthroughs – in both basic research and downstream commercialisation – were only made possible by direct public investment. In each of these areas the private sector only entered much later, piggybacking on the technological advances made possible by public funds.

In countries that have achieved smart, innovation-led growth, the state has often supplied the patient strategic finance that the private sector was unwilling to provide. In these places, the state has not just sought to fix market failures but has acted boldly to create new technological and industrial landscapes by acting as investor of first resort, not simply as lender of last resort. This has taken different institutional forms, but in many countries patient strategic finance is increasingly coming from national investment banks (NIBs).


State investment banks and patient finance: An international comparison

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(Extract from p. 7)

Governments around the world are increasingly seeking economic growth that is smart (innovation-led), inclusive and sustainable. They are seeking to achieve this in a context of major social and environmental challenges such as tackling climate change, improving public health and adjusting to demographic changes.

In this context, industrial and innovation strategies can be key pillars to achieve transformational change. The case for building a modern industrial strategy around well-defined ‘missions’ that are focused on solving important societal challenges is compelling and increasingly recognised. This involves making strategic investments across many different sectors and nurturing new industrial landscapes to steer the path of growth and innovation. The structural of the financial system is key to achieving this goal.

6. References


14 For various examples visit the http://www.unep.org/inquiry


21. We use financial policy as short-hand to incorporate monetary policy, financial regulation and credit policies carried out by both central banks and financial supervisory authorities. It should be noted that monetary policy and financial supervision can be carried out by separate institutions depending on the country in question.


29. NGFS. (2019), ibid.

30. NGFS. (2019), ibid.


32. Financiers and investors could include pension funds, commercial banks, investment banks, public sector institutions, and even households; while, other industries dependent on the fossil fuel sector could include electrical, transport, heat and other industrial processes.


34. see Golledge, A., Pike, T. and Eckersley, P. (2016). Car finance – is the industry speeding? [Blog]. Bank Underground. Available at: https://bankunderground.co.uk/2016/08/05/car-finance-is-the-industry-speeding/


45 Our calculations suggest the average balance sheet size of the FED, Bank of Japan, European Central Bank and Bank of England was approximately 10% of GDP in 2008, growing to roughly 45% of GDP in 2017.


47 Gross value added is simply a measure of the output — goods and services — produced by a particular sector, industry, or region.


49 For example, the Danish company Vestas Wind Systems A/S is the largest manufacturer of wind turbines in the world by installed capacity, but it is ineligible for the ECBs corporate asset purchases.


52 For example, with a 3% capital requirement for every extra £100 or €100 that the bank wishes to lend, it must retain an extra £3 or €3 from its earnings or raise an extra £3 or €3 from its shareholders.


56 2 degrees investing (2017) ‘All swans are black in the dark’, https://2degrees-investing.org/hit-miss-copy


59 Such as subsidized loan rates for priority sectors, differential rediscout rates, direct budgetary subsidies, credit floors, credit ceilings and the encourage of specialized financial institutions.


61 Known as the Targeted Long-Term Refinancing Operations (TLTROs).


70 European Commission. (2019). The European Green Deal Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. Available at: https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf


