Innovate UK
Technology Strategy Board

A mission-oriented approach
to building the entrepreneurial state

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Her new book The Entrepreneurial State: debunking private vs. public sector myths (Anthem, 2013) was shortlisted for the prestigious Wirtschaftsbuchpreis in Germany and on the 2013 Books of the Year list of the Financial Times, and Forbes. It focuses on the need to develop new frameworks to understand the role of the state in economic growth – and how to enable rewards from innovation to be just as ‘social’ as the risks taken.

Professor Mazzucato is winner of the New Statesman SPERI Prize in Political Economy and in 2013 the New Republic called her one of the ‘3 most important thinkers about innovation’. She advises the UK government and the EC on innovation-led growth. Her research outputs, media engagement, and talks (including her TED Global talk), can be found on her website.

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Abstract
Many western countries are pursuing innovation-led ‘smart’ growth so to rebalance away from consumer debt driven growth and ‘financialization’. This paper argues that innovation-led growth is a major battle that requires public policy to fundamentally change from one that views the goal of government as simply fixing markets to one that views it in terms of actively creating and shaping markets. Indeed, those ‘mission-oriented’ investments that led to putting a man on the moon (with the resulting technological spill-overs) - and are today catalysing investments to tackle climate change world-wide - required dynamic public agencies to be active in shaping and creating new market landscapes. The paper considers four key questions which arise from such a ‘market creating’ framework: decision-making on the direction of change; the nature of (public and private) organisations that can welcome the underlying uncertainty and discovery process; the evaluation of mission-oriented and market creation policies; and the need to share both the risks and rewards underlying the innovation process—so that ‘smart’ innovation-led growth can also become ‘inclusive’ growth. The paper is meant to serve as a ‘think piece’ for Innovate UK so that it can think more broadly and strategically about its role at the centre of the economic growth process.
1. Introduction

How to deliver smart, sustainable economic growth is the central question facing developed economies today. In the UK, the debate has focused on how to rebalance away from consumer debt driven growth towards a smarter, innovation-led growth model. This battle is enormous. It requires bringing innovation to the centre of growth policy—and in doing so, radically rethinking the traditional role of government and public policy in the economy. In essence, we need a new policy framework which is about market making and market shaping, not just market fixing. It also requires making sure the private sector is equally committed to investing in innovation, reversing the current trend towards ‘financialization’ in which many companies are spending more on boosting short term stock prices than on investing in long run areas.

This paper reflects on the reasons why market failure theory in economics, used by policy makers world wide, results in a limited framework to justify the type of policies that are needed to allow innovation to become central to growth policy, and, in turn, agencies like Innovate UK (the new name for the Technology Strategy Board) to become central to that activity. Growth depends on all aspects of demand: private consumption, private business investment, government spending and net exports. Much of innovation policy is aimed at measures directed at getting the private sector to increase their investments in innovation. This is especially problematic in countries like the UK that are characterised by low gross R&D spending to GDP (GERD, Figure 1) and also low business spending to GDP (BERD, Figure 2). Yet such measures are often too indirect, assuming that all that is needed are incentives, through different types of tax incentives (e.g. R&D tax credits). Evidence instead suggests that business tends to invest seriously in innovation only when market and technological opportunities are in sight. And the latter are strongly correlated with direct (not indirect) government investments in new areas characterised by high capital intensity and high technological and market risks. These investments have not been driven by the need to ‘fix’ narrow market failures, but by the mission to solve societal and technological challenges. The paper argues that understanding this dynamic requires a policy framework that is geared towards shaping and creating markets not only fixing them.

Innovation-led growth requires investing in key innovation ‘inputs’, such as Research & Development (R&D), and building dynamic ‘systems’ of innovation that allow new knowledge and innovation to diffuse throughout the entire economy. Systems and eco-systems of innovation (sectoral, regional, and national) embody dynamic links between the different innovation actors and institutions (firms, financial institutions, research/education, public sector funds, intermediary institutions) as well as horizontal links within organisations and institutions (Freeman, 1995). In countries that have achieved innovation-led ‘smart’ growth, such institutions have been essential for not only fixing ‘market failures’, and ‘system failures’, but for also actively shaping and creating new markets (Mazzucato, 2013a).

Innovate UK is a fundamental part of the UK innovation system of innovation. Part of its mission is indeed to help achieve the dynamic links between firms, the science base and of course financial institutions. This paper argues that for Innovate UK, and other UK innovation agencies, to have a central role in innovation-led economic growth, it is essential for its policies to go beyond the market failure framework (explained in Section 3) which continues to justify policy intervention in different domains. What is needed is a ‘market creation’ framework. John Maynard Keynes argued that “Practical men, who believe themselves to be quite exempt from any intellectual influence, are usually the slaves of some defunct economist” (Keynes, 1934, p. 383). Indeed, it will be argued there that a market creation framework requires policy makers to be freed from the shackles of
market failure theory. Only in this way will innovation go to the heart of economic growth policy, rather than be side-lined to (politically) unstable areas of industrial policy.

For innovation to become central to growth policy the UK Treasury and the UK Department for Business Innovation and Skills (BIS) must work together more coherently and consistently. Yet there has been a lack of connection between centrally directed fiscal policy and policies around innovation and industrial strategy. Emerging evidence that the spending multiplier is higher when spending is ‘directed’, creating dynamic spill-overs between technological development, productivity, and job creation (Tassey, 2012)—is indeed the micro–macro connection that is missing in modern-day economics. Productive investments generate growth, and when
spending is more ‘directed’ towards broadly defined areas like IT in the 1980s and 1990s, and the green economy today, the multiplier effect is stronger. As Tassey (2012) argues: “…the highest order problem is the long-term inadequacy of productivity enhancing investments (technology, physical, human and organizational capital). Increasing the demand for housing does have a multiplier effect on that industry’s supply chain, but this effect pales compared to the leverage from investment in technology for hardware and software that drive productivity in many industries. Equally important, the jobs created by a technology-driven supply chain are much higher paying – but, they must be sustained over entire technology life cycles.” (Tassey 2012, p.31)

Bringing innovation to the heart of growth policy means allowing agencies like Innovate UK to consider alongside the Treasury the ways to allow money creation and spending to be more ‘directed’. Is it enough for government policy to ‘create the horizontal conditions’ for innovation (education, research and infrastructure), and ‘facilitate’ innovation in the private sector, and wait for the ‘market’ to decide the direction of that change? Or must the public sector also be innovative itself, invest in its own capacities and resources, and actively invest in particular areas that determine the directions of change—setting the boundaries within which private sector innovation and experimentation happen? These questions bring us to the heart of the criticisms about ‘picking winners’ and ‘crowding out’ which are often directed at agencies like Innovate UK, or any active public sector agency, which is seen as going beyond fixing narrow market failures (e.g. the BBC is also accused of crowding out private broadcasters in an existing market, without indicators of its market shaping role).

The question on directionality (choosing areas of change, rather than just ‘facilitating’ it) are crucial because innovation has both a rate and a direction (Stirling, 2008). While there is much discussion about the former, the latter raises concerns about ‘picking winners’. Yet as I argue in The Entrepreneurial State: debunking public vs. private sector myths (Mazzucato, 2013a), every technology that makes the iPhone a ‘smart’ phone, was indeed picked and funded by government (see Figure 3 for public investments that led to GPS, Internet, touch screen display, and the SIRI voice activated system). This is also true of many high tech firms like Compaq and Intel, which received early stage financing not from private venture capital, but from agencies like the Small Business Innovation Research Programme of the US government (Mazzucato, 2013a), or equivalent programmes like Yozma in Israel, or SITRA in Finland. Indeed, with the increasing short-termism of private venture capital (seeking an exit in 3 years while innovation can take 15-20 years), such public finance has become even more important over time even in developed economies (Mazzucato and Penna, 2014; Mazzucato and Perez, 2014).

Figure 3 Public investments that make the iPhone ‘smart’ (source Mazzucato, 2013a, p. 109)
The worry about ‘picking winners’ thus ignores that choices have always been made, and it was these choices that allowed new sectors to emerge, from the internet economy to the biotechnology industry and today’s developments in both nanotechnology and clean-technology. Even the recent advances in shale gas (fracking) were funded initially by government, which ‘chose’ that trajectory (Breakthrough Institute, 2013). Picking does not have to imply a ‘top down’ bureaucratic process. It can be a dynamic decentralised process led by a host of different types of public institutions. In the UK, it would include agencies like the Medical Research Council (responsible for the greatest advancements in molecular antibodies), and the Innovate UK. In the US this would include a wide variety of institutions from the National Science Foundation (NSF), the National Institutes of Health (NIH), Advanced Research Projects Agency (in both defence, DARPA, and energy, ARPA-E) and the National Nanotechnology Initiative (NNI) (Block and Keller, 2012). Figure 4 shows the wide variety of public organisations that have been very active along the entire innovation chain in the USA. A classic market failure framework has difficulty in justifying such active policy which includes not only investments in ‘public goods’ like basic research (e.g. NSF), but also applied research (e.g. ARPA-E) and early stage seed financing of companies (SBIR, Small Business Innovation Research)—ie investments along the entire innovation chain. Indeed, as can be seen in Figure 5 the scale of public SBIR funding has increased over the course of the years, precisely because private venture capital has become more short-termist (Mazzucato 2013b). Neither the breadth of such policy making nor the depth (with the National Institutes of Health spending close to $32 billion per year) can be justified from the classical market failure approach. Indeed, market enthusiasts often accuse such organisations of ‘crowding out’ private sector activity, an argument we return to below after considering the limitations of the market failure framework and its implications for evaluation of public investments.

Figure 4 Public and private investments along innovation chain
(source: author’s addition of public agencies to underlying figure by Auerswald and Branscomb 2003)
Not only do these institutions work closely with scientists in universities, but when they are also able to attract expertise and talent within their organisations, the process of decision making is science led not ‘bureaucracy led’. Indeed, the fact that the Department of Energy in the USA was until recently led by a Nobel Prize winning physicist (Dr. Steven Chu) is tightly correlated with the fact this agency is mission-oriented and it’s an ‘honour’ for a scientist to lead it. Under his leadership, ARPA-E was formed, which is today trying to stimulate innovation in renewable energy as DARPA did in information technology—investing in the high risk projects that the private sector wont fund. Such investments are often directed via procurement, thus pushing both on the supply side and the demand side. The latter is key for creating the ‘market’ for technologies which then stimulate further private sector activity, given that business tends to only invest when clear market opportunities are in sight.

Directionality has often been led by socio-economic ‘challenges’ or technological ‘missions’, which created general purpose technologies (Ruttan, 2006). And the deployment of these technologies was also affected by policies, such as the role that suburbanization (policies) had on the diffusion of the mass production revolution (Mazzucato and Perez, 2014). This paper will reflect on the lessons to be learned about the scale and scope of directed innovation policy from ‘mission-oriented policies’ that were aimed at security concerns, and more recently socio-economic concerns around health and energy (Mowery, 2010; Foray et al. 2013).

This is not a traditional paper about innovation policy. It does not aim to provide narrow answers to narrow questions (e.g. what type of science industry links to produce), but to provide a fresh list of new questions that arise from positioning innovation policy in a market creation framework. The key areas of discussion will be around the ‘direction’ of change, the organisational dynamics needed to foster such change, new measures to evaluate ‘transformational’ public investments, and the distribution of risks and rewards between the public and private sectors so that the growth that ensues is not only ‘smart’ but also more ‘inclusive’.

The paper is structured as follows. Section (2) considers the context of challenge driven innovation for the key question about directionality, and finishes with the related questions on organisations, evaluation and rewards. Section (3) reviews the market failure framework in detail so that moving beyond it is based on a clear understanding of the way it directs different types of innovation policies (from financing public goods like basic research to seed financing subject to asymmetric
information). Section (4) uses insights from various (heterodox) literatures in economics for moving beyond the market failure framework, and towards a market creation framework. Section (5) uses these insights to pose new challenges for the role of active market creating agencies like Innovate UK in the UK.

2. Societal Challenges and opportunity driven investments

Innovation agencies in countries or in transnational organisations like the European Commission, are increasingly considering the socio-economic-technological ‘challenges’ for innovation policy (see the Innovation Union Flagship Initiative in the EC2020 strategy). Whether these challenges are the battle against climate change or the demographic-ageing crisis, the idea is that innovation policy should produce solutions for societal problems and missions.

A key goal for this think piece is to allow such challenge driven innovation policy to be guided by a new economic policy framework that can guide the way in which policy makers envision the transformational changes required (catalytic and radical, as well as the more incremental), take the associated risks (as most attempts will fail), and organise the institutions needed to manage the underlying exploration, learning and uncertainty. The framework proposed here draws on and advances an analysis and ‘narrative’ of the role of public policy in the economy that differs from that of traditional market failure policy framework in economics.

Societal challenges such as climate change, youth unemployment, obesity, ageing, and rising inequality have helped form a new agenda for innovation and growth policy that requires politicians and policymakers to ‘think big’ about what kind of technologies and socio-economic policies can fulfil visionary ambitions to make growth more ‘smart’, ‘inclusive’ and ‘sustainable’ (EC Innovation Union; OECD Innovation Strategy). Although such challenges are not strictly technological (and in fact require also behavioural and systemic changes), they have much to learn from those ‘mission-oriented’ feats that led to putting a man on the moon, or to those that led to the emergence of new general-purpose technologies, from the Internet to biotechnology and nanotechnology (Foray et al., 2012; Ruttan, 2006). Achieving those missions required the public and private sectors to work together to create new technologies and sectors. Most of all, they involved a confident state that was able and willing to courageously envision the direction of change-defining missions and to organise institutional structures across public agencies and departments. They entailed a state that welcomed the associated risks and extreme uncertainties across the entire innovation chain (not only the upstream basic research), and the experimentation processes required for organisational learning (Mazzucato, 2013a; Rodrik, 2013).

Today’s societal challenges, which combine social, political, economic and technological ambitions, are indeed the new ‘missions’, which necessitate a similar if not greater level of visionary investment and state capacity. Yet, we are living through a crisis of imagination with regard to the role of the state in the economy—what Judt (2011) called a ‘discursive’ battle. By limiting our understanding of the role of the public sector to one that simply ‘administers’, ‘fixes’, ‘regulates’, ‘spends’, ‘meddles’, and at best ‘facilitates’ and ‘de-risks’ the private sector, we are unable to think creatively about how to allow public sector vision, risk-taking and investment to lead and structure the needed transformational changes. This ‘think piece’ paper seeks to provide a new framework through which such vision and ambition can be formulated, guided, organised, evaluated and managed.

Key to the problem is that the prevailing policy framework in economics justifies state intervention only if it is geared towards fixing situations in which markets fail to ‘efficiently’ allocate resources. This market failure approach suggests that governments intervene to ‘fix’ markets by investing in areas with ‘public goods’ characteristics (such as basic research, or drugs with little market potential) and by devising market mechanisms to internalise external costs (such as pollution) or
external benefits (such as herd immunity). According to this approach, the state should only aim to fix a market failure if such an action does not lead to an even worse outcome due to ‘government failure’ (Tullock et al., 2002). For instance, the state should intervene in a way that does not displace (‘crowd out’) private enterprise, which is judged to be superior in selecting and managing investments (Friedman, 1979). In other words, the state should not ‘direct’ the economy or try to ‘pick winners’; it should step back and concentrate on facilitating private initiative and ‘optimising’ market performance to maximize the rate of progress.

The market failure framework is problematic for addressing societal challenges because it cannot explain and justify the kinds of transformative mission-oriented investments that in the past ‘picked’ directions, coordinated public and private initiatives, built new networks, and drove the entire techno-economic process, thus resulting in the creation of new markets—not just in the fixing of existing ones. The market failure approach is more useful for describing a steady state situation in which public policy aims to put patches on existing development trajectories provided by markets, but not to dynamically create and shape new trajectories. The main problem is that market failure theory does not embody any justification for the kind of mission-oriented directionality (and ‘routes’ within directions) that was required for innovations such as the Internet and nanotechnology, and is required today to address societal challenges ranging from climate change to the ageing crisis. Secondly, because it lacks a clear framework that posits the objective of state policy to create and shape markets, market failure theory cannot evaluate and assess such mission-oriented investments when they happen. Thirdly, by not describing the state as a lead risk-taker and investor in this process, market failure theory has avoided a key question regarding the distribution of risks and rewards between the state and the private sector. Fourthly, by not considering the state as a lead investor and market creator, market failure theory has not produced insights about the type and structure of public sector organisations that are needed to provide the depth and breadth of high-risk investments.

The paper addresses these four challenges, by asking the following questions:

1. How can public policy be understood in terms of setting the direction and route of change; that is, shaping and creating markets rather than just fixing them (DIRECTIONALITY)?

2. How should public organisations be structured so they accommodate the risk taking and explorative capacity, and the capabilities needed to envision and manage contemporary challenges (ORGANISATIONS)?

3. How can this alternative conceptualisation be translated into new indicators and evaluation tools for public policies, beyond the micro-economic cost/benefit analysis and macro-economic appraisal of crowding in/crowding out that stem directly from the ‘market failure’ perspective (EVALUATION)?

4. How can this alternative conceptualisation be put into practice so that it results in the socialisation of risks, but also of rewards, enabling ‘smart growth’ to also be ‘inclusive growth’ (RISKS and REWARDS)?

While the questions may seem broad, it is their connection that lies at the centre of a market creation framework. Policy aiming to actively create and shape markets, requires indicators which assess their performance along that particular ‘transformational’ objective. The state’s ability and willingness to take risks, embodied in transformational changes, requires an organisational culture (and policy capacity) which welcomes the possibility of failure and experimentation, and which is rewarded for ‘successes’ so that ‘failures’ can be covered and the next round repeated.

This alternative view (policy framework) of policy making builds on the inspirational work of Karl Polanyi (2001 [1944]), an economic historian and sociologist who understood markets as being deeply embedded in social institutions, with policy not standing on the sidelines but within the very market creation process. In his epic book The Great Transformation, he described the way in
which capitalist markets are deeply ‘embedded’ in social and political institutions, rendering meaningless the usual static state vs. market juxtaposition: “[t]he road to the free market was opened and kept open by an enormous increase in continuous, centrally organized and controlled interventionism” (2001 [1944], p. 144). It also builds on John Maynard Keynes’ challenge for governments to think big: “The important thing for Government is not to do things which individuals are doing already, and to do them a little better or a little worse; but to do those things which at present are not done at all” (Keynes, 1926, p. 46). This view of policy has implications for the transformational effect of government policies, not found in macroeconomic interpretations of Keynes’ work.

Before considering an alternative analysis, it is crucial to understand the market failure framework on its own grounds.

3. MARKET FAILURE THEORY

The market failure justification of government involvement in the economy is the prevalent framework used by policy makers around the world in various policy domains, from education to health, infrastructure and innovation. While useful insights have been derived from this framework, I will show it is limited in its ability to provide guidance for transformational objectives. Throughout this proposal we take the term ‘transformational’ policies to mean the way in which policy can actively shape and create markets, not just ‘fix’ them.

Market failure theory takes the ‘First Fundamental Theorem’ (FFT) of welfare economics (Arrow, 1951) as the starting point. The FFT states that markets are the most efficient allocators of resources under three specific conditions: (1) There is a complete set of markets, so that all supplied/demanded goods and services are traded at publicly known prices; (2) all consumers and producers behave competitively (that is, all agents are price-takers); and (3) an equilibrium exists. Under these three conditions, the allocation of resources by markets is Pareto optimal (no other allocation will make a consumer or producer better off without making someone else worse off). Violations of any of the three assumptions lead to inefficient allocation of resources by markets—that is, market failures. If markets are not Pareto efficient, then everyone could be made better off through public policies that correct the market failure. Within this framework, market failure is only a necessary but not sufficient condition for governmental intervention (Wolf, 1988). The sufficiency results from an assessment that the gains from the intervention outweigh the associated costs due to ‘governmental failures’ (Tullock et al., 2002), such as capture by private interests (nepotism, cronyism, corruption, rent-seeking) (Krueger, 1974), misallocation of resources (for example, ‘picking losers’) (Falck et al., 2011), or undue competition with private initiatives (‘crowding out’) (Friedman, 1979).

Thus, there is a trade-off between two inefficient outcomes, one generated by free markets (market failure) and the other by governmental intervention (government failure). The solutions advocated by Neo-Keynesians focus on correcting failures such as imperfect information (Stiglitz & Weiss, 1981). Solutions advocated by Public Choice scholars (Buchanan, 2003) focus on leaving resource allocation to markets (which may be able to correct their failures on their own). We argue here that such solutions might hold for steady state situations, but not for the situations in which public policy is required for large technological and socio-economic missions. Such missions require an emphasis not on fixing market failures or minimising government failures but on maximising the transformative impact of policy that can shape and create markets.

Four broad categories of market failures can be described, according to the source of failure (and hence what needs ‘fixing’) and which condition of the FFT it violates. These are described below.
**MF1. Coordination failures.** These occur when agents fail to coordinate their expectations and preferences throughout the business cycle so that markets fail to reach an equilibrium (supply does not match demand; workers do not find employment; savings do not get invested). Business cycles create an intertemporal dynamic, which make it difficult to coordinate expectations and preferences, giving rise to situations in which the economy follows a Pareto-inefficient path (Stiglitz, 1974). In such situations, capital, labour and natural resources will be underutilised, because supply and demand for them do not match (Bator, 1958; Stiglitz, 1991). From this perspective, government intervention would be justified as a way to address the ‘coordination failure’ that arises from private agents’ (such as banks and firms) being too pro-cyclical (lending and investing too much in the boom and too little in the bust), putting the economy on a downwards path. Therefore, market failure theory assumes that the state is ‘risk-neutral’ and capable of absorbing risk during an economic crisis, spreading risk over time and cross-sectionally (Arrow & Lind, 1970). It is this assumption that justifies the promotion of countercyclical fiscal and monetary policies. For instance, in times of crisis, greater risk aversion of private agents may lead to underinvestment. To address this issue, the state may increase public investment to provide short-term fiscal stimulus to keep the economy running, or it may decrease interest rates in order to indirectly de-risk private investments. In this view, directionality is provided by markets. An implicit corollary of this ‘coordination failure’ intervention is that if the public sector invests too much during a boom, it risks crowding out private finance, particularly if investments are debt-financed (Friedman, 1979), but not only in such cases (for example, crowding out can also occur if public investment leads to changes in exchange rates). In such situations, it may be that ‘fiscal consolidation’ (austerity measures; contractionary fiscal policy) will result in expansion of private investments (Giavazzi & Pagano, 1990).

**MF2. Public good failures** (for example, provision of clean air or new knowledge) and situations of imperfect competition (for example, natural monopolies, network effects, supply and demand-side economics of scale). These are both key reasons for industrial policies. Wherever private lenders have limited incentives to finance projects with ‘public good’ characteristics (non-excludable and non-rival), or in situations of imperfect competition, the market is not an efficient allocator of resources, and therefore state intervention is justified. Examples include private markets underfunding of goods with very high spillovers (such as basic research that generates new knowledge) or socially desirable infrastructure projects with positive externalities—both are characterised by value that cannot be internalised by private agents. Research and development (R&D) investments generate new knowledge, which cannot be fully appropriated by the original investor (who cannot ‘exclude’ other agents from using the knowledge to their own benefit). Thus, private agents tend to underinvest in R&D and innovation, because they cannot internalise benefits that would compensate for the development costs and make the investments worthwhile. Competition failures arise when there are high natural barriers to entry (due to scale economies or network effects), which also lead to Pareto-inefficient situations (Stiglitz, 1991). In order to correct for these kinds of market failures, the state may invest in early stage blue sky research, infrastructure and other public works, enforce competition policies, regulate natural monopolies, establish early technical standards, and so on. Indeed, what links these potential sources of failures is that they all focus on using macro industrial policies to promote investments in public goods that are under-produced in prevailing market conditions or tackle situations of monopoly and monopsony (by promoting the entry of new agents to increase the pool of producers and consumers or avoiding collusion, thus fostering competition). In order to minimise the risk of governmental failure, innovation policies are often designed to be ‘neutral’, so as to not favour or disfavour specific private agents. This view became dominant in the 1990s, when ‘diffusion-oriented’ policies (focused on ‘getting the conditions right’) replaced ‘mission-oriented’ technology policies (Chiang, 1991). In the diffusion-oriented paradigm, policies to promote the supply of public goods are supposed to create the ‘right conditions’ for innovation. This is done,
for example, by de-risking the private sector (through tax incentives) not ‘picking winners’. This expression is commonly used to describe policies which are strongly directive, benefitting specific firms, technologies and sectors, which many believe will inevitably lead to government failure (Falck et al., 2011).

**MF3. Information failures** arising from incomplete markets with high transaction costs and information asymmetries; for example, bad vs. good borrowers (leading to adverse selection or moral hazard behaviours). Such market failures take place at a more microeconomic level, creating inefficiencies associated with non-equilibrium situations that result from the interaction between agents (microeconomic exchanges). For example, microeconomic Pareto inefficiencies may be caused by information asymmetries that lead to adverse selection of potentially good borrowers (Stiglitz & Weiss, 1981); or they may be the result of high costs to carry out a transaction through markets (Coase, 1960). Classic examples are the lack of finance for small enterprises or for R&D and innovation projects—both of which are risky and uncertain. Underinvestment in R&D projects due to information asymmetries can even occur in the presence of strong intellectual property laws, macroeconomic stability, free-trade, and contract enforcement, because markets are ‘incomplete’ (Stiglitz, 1991). In these situations, public investment in SMEs and innovation, through loans, equity or grants, would be justified in order to promote economic diversification, growth and development. To minimise risks of government failure through capture by private interests or of crowding out, the preferred policies should be ‘neutral’ and simply ‘de-risk’ the private sector across the board, without picking favourite firms or sectors.

**MF4. Negative externalities** arising from the production or use of goods and services such as climate change, traffic congestion, or antibiotic resistance, for which there is no market. In this perspective, most societal challenges are seen as negative externalities. Such failures work at the system level; that is, they amount to ‘system failures’. The socio-economic system as whole results in ‘costly’ outcomes that are undesirable from a societal point of view. For instance, climate change can be seen as a negative externality from carbon-intensive production methods or the burn of fossil fuels. Indeed, the *Stern Review* (Stern, 2006) on the economics of climate change states that: “Climate change presents a unique challenge for economics: it is the greatest example of market failure we have ever seen” (Stern, 2006, p. 1). Negative externalities are not reflected in the price system: there is no ‘equilibrium’ price because there is no market for negative externalities. Economists often call for market-based mechanisms (such as carbon pricing or carbon taxes) or neutral technology policies (such as tax breaks) to correct for this type of market failure, both of which would minimise the risk of government failure by leaving the direction of change to be determined by market forces.

The key contention of this paper is that while market failure theory is useful for addressing some of the confined areas above, it cannot explain and justify the more ambitious role that the state has historically played in shaping and creating markets, not just fixing them: transforming them. Behind the investments that led to key ‘technological revolutions’ and ‘general-purpose technologies’ was the active hand of the state: the ‘mass production’ system, aviation and space technologies, nuclear power, information technologies and electronics, and the Internet (Ruttan, 2006). The investments that led to the Internet, for example, were not confined to public goods areas: their breadth covered the entire innovation chain from basic research to applied research and early-stage financing of companies (Block and Keller, 2011). These investments, like those that lay behind nanotechnology and biotechnology, were driven by a vision to create new markets, not to fix ‘network externalities’ within existing ones. Thus, a new framework to guide public policies must account for the role of the state in directing investments, creating markets, taking on risks and uncertainties as lead investor—with private companies only entering later. This expanded role of the state can build on several ‘heterodox’ economics literatures which have emphasised the state’s ‘transformational’ capacity.
4. **INSIGHTS ON MARKET SHAPING/CREATING FROM ALTERNATIVE THEORIES**

Private business investment in innovation is driven not by costs but by perception of technological and market opportunities. Studies in industry dynamics have documented that there is a weak relationship between entry of new firms into industries, and the current levels of profits in those industries (Vivarelli, 2013). What seems to drive firm entry are the expectations about future growth opportunities, even if such expectations are often too optimistic (Dosi and Lovallo, 1998). And such technological and market opportunities have historically been actively shaped by government spending (Mazzucato, 2013a). This is not to say that the private sector is not important—of course it is—but historically it has tended to enter new sectors only after the high uncertainty (e.g. areas of capital intensity, and areas of high risk) were absorbed by the public sector. This was the case for the IT revolution (Block and Keller, 2012), the biotechnology industry (Lazonick and Tulum, 2011), for nanotechnology (Motoyama et al, 2011), and for the emerging clean tech sector (Mazzucato and Penna, 2014).

To develop a transformational market creation/shaping policy framework I draw on insights from different bodies of thought that have considered the role of the state in the process of fostering innovation-led growth. These are: (a) *science and technology policy research* (on mission-oriented policies); (b) *development economics* (on ‘developmental states’); (c) *evolutionary economics* (on shifts in technological trajectories and techno-economic paradigms); and (d) my own work (Mazzucato, 2013a) on the ‘Entrepreneurial State’ on the lead risk-taking role of government. The fact these theories have not been linked and have not been clearly positioned to critique the key tenets of market failure theory has prevented them from having the impact they could have had on our understanding of how to guide, evaluate and manage public policy.

**a) Science and Technology Policy Research: Mission-Oriented Innovation Policy**

The history of innovation policy, studied especially through the ‘systems of innovation’ approach (Freeman, 1995), provides key insights into the limits of market failure theory in justifying the depth and breadth of investments that have been necessary for the emergence of radical technological change. Innovation policy has historically taken the shape of measures that (1) support basic research, (2) aim to develop and diffuse general-purpose technologies, (3) develop certain economic sectors that are crucial for innovation, and (4) promote infrastructural development (Freeman & Soete, 1997 [1974]). The *justification* of innovation policies have changed over time: in the 1950s and 1960s, military motives predominated, while the aim since the 1970s has been to improve economic and competitive positions. In the 1980s, innovation policy became increasingly justified due to ‘market failure’. The kind of innovation policies driven by military motives has been described as ‘mission-oriented’ because they aimed to achieve clearly defined technical goals. In recent years, there have been calls for a return to such policies to address ‘grand societal challenges’ (Mowery et. al, 2010). However, Foray et al. (2012) contrast missions of the past, such as putting a man on the moon, with such contemporary missions as tackling climate change. While missions of the past aimed to develop a particular technology (with the achievement of the technological objective signalling that the mission was accomplished), contemporary missions address broader and more persistent challenges, which require long-term commitments to the development of technological solutions. Indeed, the *Maastricht Memorandum* (Soete & Arundel, 1993) provided a detailed analysis of the differences between ‘old’ and ‘new’ mission-oriented projects, showing that “older projects developed radically new technologies through government procurement projects that were largely isolated from the rest of the economy, though they frequently affected the structure of related industries and could lead to new spin-off technologies that had wide-spread effects on other sectors. In contrast,
[contemporary] mission-oriented environmental [and other] projects will need to combine procurement with many other policies in order to have pervasive effects on the entire structure of production and consumption within an economy” (p. 50). While many mission-oriented policies used to be tied to military motives (such as the origin of DARPA in the US Department of Defence), they have more recently been used to set up dynamic public agencies in other mission-oriented areas like energy security (ARPA-E) and health (National Institutes of Health, NIH). Indeed, the NIH is the second biggest pot of innovation funding after the Department of Defence, with spend in 2012 reaching $32billion. Angell (2005) claims that such expenditures are the source of most of the radical innovations in the sector, i.e. new molecular entities with priority rating (with private pharma focusing more on the incremental drugs and on development).

The mission-oriented literature has developed many useful empirical studies, such as analysis of different technology policy initiatives in the USA (Chiang, 1991; Mowery et al., 2010), in France (Foray, 2003), in the UK (Mowery et al., 2010), and in Germany (Cantner & Pyka, 2001); and studies of mission-oriented agencies and policy programs, including military R&D programs (Mowery, 2010), the National Institutes of Health (Sampat, 2012); grand missions of agricultural innovation in the USA (Wright, 2012); and energy (Anadón, 2012), among others. However, the literature has not integrated the empirical insights to provide a fully-fledged theory that contrasts its position to that of the four market failure categorisations discussed above. Consequently, the studies have resulted in ad-hoc theoretical understandings and policy advice on how to manage mission-oriented initiatives, without tackling the key justifications for mission-oriented investments in a way that contrasts the justifications to those of market failure. In particular, the framework has been limited to looking at agencies that focus on science, technology and innovation policies. Doing so ignores the relationship between types of finance and innovation development, and overlooks, for example, the rise of public financial institutions like state investment banks (such as KfW in Germany or the China Development Bank, Sanderson & Forsythe, 2013 ) as sources of mission-oriented finance, especially as private finance has increasingly ‘retreated’ from nurturing the ‘real economy’ (Mazzucato; 2013b; Mazzucato and Penna, 2014). While mission-oriented programs are intrinsically dynamic, with feedback loops between missions and achievements, the tools used to evaluate such public policies have remained static, coming from the market failure theory toolbox (despite the fact that many studies draw on the innovation systems perspective from evolutionary economics). For these reasons, mission-oriented policy research is currently confined to a small area of policy research and practice, and has had very little impact on how economists understand the role of public policy. One particular limitation is that this stream of research has continued to assume that innovation and dynamism are housed inside firms, with the state only playing a facilitating role. A new framework must thus seek to address the mismatch between theory and practice by developing a new economic policy framework that is able to explain and justify the kinds of mission-oriented policies that have led to the shaping and creation of new markets, and not to the correction of markets.

b) Development Economics: Developmental Network States

Work on the ‘developmental state’, a concept from a small group of development economists, has revealed the importance of the ‘visible hand’ of the state in industrialisation and technological change (Wade, 1990; Chang, 2002; Amsden, 2001). More recently, this literature has also emphasised the ‘developmental network state’ as key: a decentralised network of different types of state agencies that can foster innovation and development. While there has been significant attention placed on the role of large agencies or institutions (such as DARPA or the NIH) in historical mission-oriented projects, until recently less focus has been placed on the broader network of structures, actors, strategies and agencies, such as intelligence distributed amongst actors and institutions, flat organisational structures, flexibility, and customisation (Perez, 2002).
Indeed, many successful cases of innovation and technology policy strategies have been carried out by networks of decentralised public institutions, which have focused not on creating individual ‘national champion’ firms, but on establishing a constellation of innovative firms (O’Riain, 2004). This has been the case in East Asia, Finland, Israel, Taiwan, and even in Silicon Valley in the US (Block and Keller, 2011). Such successful policies have covered a wide range of measures, including R&D support, training, support for marketing and export, funding programs (including early-stage venture capital), networking and brokerage services, building of facilities and clusters (‘science parks’), and fostering industrial ties. Not all networks of decentralised institutions were driven by a technological mission, but this has been the case with the networks fostered by DARPA (driven by security mission) or the NIH (health/cure of diseases), two of the most successful cases of mission-oriented initiatives. In the case of East Asia, the implicit mission was industrial development and ‘catching up’ (Chang, 2002).

From this alternative view, economic development is not the result of natural (exogenous and ex-ante) competitive advantages, but of the endogenous creation of new opportunities that lead to the establishment of competitive advantages. This requires discovering the cost structure of an economy in order to identify which types of goods and services that already exist in world markets can be produced in a domestic economy at low cost (Rodrik, 2004). The state plays a central coordinating role in this discovery process, and often represents a lead agent in economic development efforts. To do this, the state may work as an agency to nurture nascent or knowledge intensive firms (‘infant-industry promotion’); promote strategic trade (such as import substitution) and financial leverage; prioritise investments in existing strategic sectors (reinforcing comparative advantages); create ‘national champions’; and provide coherence to economic policies (Wade, 1990; Amsden, 2001; Chang, 2002; Reinert, 2007; Falck et al., 2011). While the need for some of these activities may be explained by market failure theory (for example, infant-industry promotion as a result of adverse selection by private investors), by fulfilling this developmental role, the state does much more than just provide financial capital to fix failures. Because economic development is an endogenous process, the state provides social capital, coordinates initiatives and public-private partnerships, fosters synergies, and promotes the introduction of ‘new combinations’ that create Schumpeterian rents (Reinert, 2007).

c) Evolutionary Economics: Technological Trajectories and Techno-Economic Paradigm Shifts

Schumpeter warned that the methodology of neoclassical economics (based on ‘comparative statics’; that is, the comparison of static equilibrium situations) and its treatment of technical change as an exogenous process—both of which market failure theory adopts—were “not sufficient to explain the real development of the economy” (Schumpeter, 2002 [1912], p. 97). Evolutionary economists following the Schumpeterian tradition aimed to ‘open the black box of technical change’ (Rosenberg, 1982) by means of a different methodology (based on historical analysis and empirical evidence) in order to understand the process that links technical change (innovation), economic growth and development. Key concepts developed in evolutionary economics are those of ‘technological paradigms’ and ‘technological trajectories’ (Dosi, 1982; Nelson and Winter, 1982), which reveal the limitation of market forces in providing a direction to economic development. A technological paradigm has a threefold definition (Dosi, 1982, p. 148): it is an outlook of the relevant productive problems confronted by firms (as producers of technologies or innovators); it represents a set of procedures (routines) of how these problems shall be approached; and it defines the relevant problems and associated knowledge necessary for their solution. A technological trajectory, in turn, represents the direction of progress within a technological paradigm. Therefore, technology development is a problem-solving activity, and a technological paradigm “embodies strong prescriptions on the directions of technical change” (p. 152). This is why market signals are limited in terms of providing direction to techno-economic development; they only work within the parameters of the paradigm, and thus influence more the
rate of change than its direction. When two or more technological paradigms compete, markets may influence which one is selected (the one which minimises costs). Once established, however, paradigms have a powerful ‘exclusion effect’, whereby some technological possibilities are discarded because they are incompatible with the prevailing paradigm and are therefore ‘invisible’ to agents. Thus, a techno-economic system of innovation may be locked into a self-reinforcing, path-dependent trajectory (Dosi & Nelson, 1994). This becomes a problem if the trajectory being followed (or the paradigm itself) is inferior or suboptimal to what could be achieved with technologies that transgress the paradigm (or with a different paradigm).

Perez (2002) expands the notion of technological paradigm to ‘techno-economic paradigm’ in order to account for the non-technological forces (economic and social institutions) that characterise certain periods of capitalist history and affect both the economic and social systems. Her theory of ‘techno-economic paradigm’ shifts is a historical perspective on the long-waves of development that accompany technological revolutions. “A techno-economic paradigm is, then, a best-practice model made up of a set of all-pervasive generic technological and organisational principles, which represent the most effective way of applying a particular technological revolution and of using it for modernising and rejuvenating the whole of the economy” (Perez, 2002, p. 15). When a new technological revolution emerges, the socio-economic system remains stuck within the bounds of the previous paradigm, which means that market forces are incapable of directing the system towards the new paradigm and the modernising and rejuvenating potential of the new revolution is stifled. In other words, there are mismatches between elements of the social and techno-economic systems (for example, social expectations, R&D routines, tax regimes, labour regulations, etc.). In order to overcome these mismatches, it is necessary to build new institutions that favour the diffusion of the new paradigm. In all previous technological revolutions, governments have led the process of institution-building that allowed new techno-economic paradigms to replace the old ones. Perez (2002) specifically points to the role of public policy in allowing the full deployment of technological revolutions, such as the effect of suburbanization on the ability of the mass production revolution to diffuse throughout the economy.

This stream of research on technological and techno-economic paradigms highlights the importance of cognition when establishing the direction of technological change. Paradigms are powerful enabling and constraining institutions that favour certain directions of techno-economic development and obstruct others. In order to redirect techno-economic development on a new, qualitatively different route, we need a paradigm shift that will avoid the constant renewal of prevailing trajectories, which happens if market forces provide directionality to the system. From this perspective, the state has a crucial role to play, in terms of creating a new vision that will coordinate cognitive efforts of different (public and private) agents and direct their action to areas beyond the existing paradigm. ‘Green’ innovation can be understood as a redirection of the full deployment of the IT revolution (Perez, 2010). To be effective in providing the direction of change, a vision must be created and shared. Stirling (2008) rightly focuses on the role of bottom-up participatory processes to ensure directionality is taken seriously and shared amongst actors.

d) ‘The Entrepreneurial State’: the State as Lead Risk-Taker and Investor in the Economy

In the book The Entrepreneurial State: Debunking Public vs. Private Sector Myths (Mazzucato, 2013a), I described the risk-taking role the state has played in the few countries that have achieved innovation-led growth. I focused on the way in which the state played a lead investment role across the entire innovation chain, from basic research to early-stage seed financing of companies. I argued that ignoring the high risk and uncertainty that the state has absorbed has caused the fruits of innovation-led growth to be privatised, even though the underlying risk was socialised. It is usually assumed that the returns to the state will occur through higher tax income. However, I argued that this return-generating system is broken, and suggested that more thinking
is needed on concrete ways in which direct mechanisms can be generated for the state to create a ‘revolving fund’, so that inevitable losses (innovation is uncertain) can be covered, and the next round funded—as is the case with private venture capital. A key area of research that is needed is the accumulation of evidence from across the world on how such return-generating mechanisms are used, and to consider the implications of the state as a (sort of) public venture capitalist, which can follow a portfolio approach allowing the returns from the successes to cover the losses from the failures—with enough left over to cover the next round of investments. How to do this while also retaining a mission-oriented perspective (not limited by cost-benefit analysis), is a key challenge.

5. BEYOND MARKET FAILURE: ROUTES, ORGANISATION, ASSESSMENT & REWARDS

This section brings together key concepts from the four heterodox frameworks reviewed above, drawing especially on the empirical research done within these, in order to provide a new theoretical conceptualisation for guiding state action to tackle transformational change.

**Directionality: the role of the state beyond fixing market failures.** Policies that aim to correct markets assume that once the sources of the failure have been addressed, market forces will efficiently direct the economy to a path of growth and development. Yet, markets are ‘blind’ (Dosi, 1982) and the direction of change provided by markets often represents suboptimal outcomes from a societal point of view. This is why, in addressing societal challenges, states have sometimes led the process and provided the direction towards new ‘techno-economic paradigms’, which did not come about spontaneously out of market forces. In the mass production revolution and the IT revolution, governments made direct investments in the technologies that enabled these revolutions to emerge, and formulated bold policies that allowed them to be fully deployed throughout the economy (Ruttan, 2006; Block and Keller, 2011). Examples include suburbanisation policies that allowed mass production to affect the productivity of all sectors, or the military motives that allowed IT to begin its deployment phase (Perez, 2002). Furthermore, in the IT revolution, and even in the emerging clean tech revolution, government not only funded the actual technologies (such as mainframes, the Internet, wind and solar power, and fuel cells), but also provided early-stage funding to companies that risk-averse private finance would not, and devised special tax credits that favoured some activities more than others (Mazzucato, 2013a).

These facts seem to point to a different analytical problem facing policy makers: choosing whether the right role is to direct or stand back, understanding how particular ‘directions’ and routes can be picked, and determining how to mobilise and manage activities that can lead to the achievement of dynamic social and technological challenges.

The problem is not whether to pick or not to pick a direction but how to learn from the successful picking of the past, and to enable the directions picked to be broad enough to allow bottom up exploration, discovery and learning. This is sometimes referred to as ‘smart specialisation’ (Foray, David and Hall, 2009). Smart specialisation is explicitly a results and outcome oriented agenda not input or outputs oriented agenda (Rodrik, 2004). Yet the fact it has until now been based on a market failure framework means that at best its seen as a ‘discovery’ process for stakeholders and policy-designers to identify together different bottlenecks, market failures, and missing links. What it has not addressed is the way in which innovation-led growth in places like Silicon Valley actually happened - requiring not only identifying missing links but forming concrete strategies towards producing market landscapes that simply did not exist.

**Organisation: learning, experimentation and self-discovery.** If brought to its extreme, as advocated by critics from Public Choice and the Chicago School of Economics, market failure theory calls for the state to intervene as little as possible in the economy, in a way that minimises the risk of ‘government failure’, from crowding out to cronyism and corruption. This view requires
a structure that *insulates* the public sector from the private sector (to avoid issues such as agency capture) and has resulted in a trend of ‘outsourcing’ that often rids government of the knowledge capacities and capabilities (for example, around IT) that are necessary for managing change (Kakabadse & Kakabadse, 2002). Studies have examined the influence of outsourcing on the ability of public institutions to attract top-level talent with the relevant knowledge and skills to manage transformative mission-oriented policies. Without such talent and expertise it is nearly impossible for the state to fulfil its role of coordination and provision of direction to private actors when formulating and implementing policies that address societal challenges. In order to promote transformation of the economy, by shaping and creating technologies, sectors and markets, the state must organise itself so that it has the ‘intelligence’ (policy capacity) to think big and formulate bold policies. If the state is essential to the process of transformative technological and socio-economic change, then understanding the appropriate structure of public organisations is also essential. Innovation is subject to extreme uncertainty, which creates the need for both patience (‘patient long-term capital’, Mazzucato, 2013b) and the ability to experiment and explore the underlying landscape (Rodrik, 2004). Therefore, a crucial element in organising the state for its ‘roaring’ role is ‘absorptive capacity’ (Cohen and Levinthal, 1990) so that governmental agencies learn in a process of investment, discovery and experimentation.

The size of the state, and hence its ability to earn back a return either through tax or other means to fund its size, depends on its purpose. If the role of the state is to simply correct market failures and perform a subsidiary role to private initiative, it is sufficient to have little more than a ‘minimal state’ that performs only ‘unanimously approved’ functions, such as guaranteeing property rights and enforcing contracts (Atkinson & Stiglitz, 1980). Indeed, the use of market failure as a diagnostic tool for public policies became prominent in the 1980s and was accompanied by public administration reform initiatives that sought to ‘modernise’ (often through downsizing) the state apparatus (Pollitt & Bouckaert, 2004), often in line with tenets from Public Choice theory (Buchanan, 2003). If policymaking is seen (i) as a non-probabilistic risk-taking process surmounted by uncertainty about technical and economic outcomes (Mazzucato, 2013a); (ii) as a process of experimentation and discovery (Hirschman, 1967; Rodrik, 2004); and (iii) as a continuous process of learning that leads to some successes and failures measured beyond static monetary analysis of the costs and benefits attached to quantifiable outcomes, then the *size* of the state apparatus and purely *economic efficiency* of the state are the wrong focuses for organising the state.

This suggests that the key concern should be to establish which skills/resources, capabilities and structures are useful to increase the chances that a state organisation will be effective both in *learning* and in *establishing symbiotic partnerships with the private sector*—and ultimately succeed in implementing mission-oriented and transformative policies. Furthermore, it is crucial to explore alternative ways through which the state may engage with and assume risks. It does this not by adopting a conservative strategy that minimises the risks of picking losing projects and maximising the probability of picking winners, but by adopting a portfolio approach for its investments (Rodrik, 2013). In such an approach, (a) success from a few projects can cover the losses from many projects and (b) the state learns from its losing investments (Mazzucato, 2013a). What matters in this approach is not so much the matching between failures and fixes, but an institutional structure that ensures winning policies provide enough ‘rewards’ to cover the losses, and that losses are used as learning cases to improve and renew future policies. The work on the developmental state (Block and Keller, 2012) suggests that these goals are best achieved not through a top down policies but through a decentralised structure where the organisation/s involved remain nimble, innovative and dynamic from within.

**Evaluation: static vs. dynamic metrics.** The market failure framework has developed concrete indicators and methods to evaluate government investments, which stem directly from the framework itself, usually through a cost-benefit analysis that estimates whether the benefits of
public intervention compensate for the costs associated both with the market failure and the implementation of the policy (including ‘governmental failures’). However, there is a mismatch between the intrinsically dynamic character of economic development and the static tools with which the role of the state in the process is evaluated. The mainstream diagnostics and evaluation approach (based on market failure theory) involves identifying the sources of the market failure and targeting policy interventions on their correction. It mostly entails ex-ante considerations about administrative and fiscal requirements and political-economic consequences of the intervention (Rodrik, 2004). Such an exercise usually consists of the following steps:

- An ex-ante cost-benefit analysis that weighs up the costs of the failure, the (private and social) benefits from addressing it, and the costs and risks of government failure.
- An ex-ante identification of sources of market failures and of second-best policy tools to address them.
- An ex-ante diagnostic of the best principal–agent structure that avoids governmental capture by private interests (insulation/autonomy) and that forces private agents to do what the principal (government) wants.
- An ex-post evaluation of the outcomes of the intervention vis-à-vis the ex-ante quantifiable prediction of the likely outcomes of the intervention.

This is a limited toolbox for evaluating public policies and investments that aim to address societal challenges, because doing so represents a static exercise of evaluation of an intrinsically dynamic process. By not allowing for the possibility that government can transform and create new landscapes that did not exist before, the ability to measure such impact has been affected, with economists often resorting to an analysis of the public sector as an inefficient private one (Mazzucato, 2013a). This is evident not only in the area of innovation, but also for public services. This then leads to accusations of government ‘crowding out’ businesses, which implies that those areas that government moves into could have been areas for business investment. Such accusations are best defended through a ‘crowding in’ argument, which rests on showing how government investments create a large pie of national output that can be shared (the savings) between private and public investors. However, this defence does not capture the fact that businesses are risk-averse and unwilling or unable to transform existing and create new landscapes (which is about creating new pies, not increasing existing pies). By not having indicators for such transformative action, the toolbox affects the government’s ability to know when it is simply operating in existing spaces or making new things happen that would not have happened anyway (its ‘additionality’). This often leads to investments that are too narrow or directed within the confines of the boundaries set by business practices of the prevailing techno-economic paradigm (Abraham, 2010).

It is thus crucial to develop a new toolbox and indicators with which to evaluate and measure the degree to which state investments open up and transform sectoral and technological landscapes, rather than operating within existing ones. The indicators must take into account the underlying risk and uncertainty in transforming such landscapes.

**Risks and Rewards: towards symbiotic private–public partnerships.** Market failure theory says little about cases in which the state is the lead investor and risk taker in capitalist economies. Having a vision of which way to drive an economy requires direct and indirect investment in particular areas, not just ‘creating the conditions’ for change. This requires crucial choices to be made, the fruits of which will create some winners, but also many losers. For example, the Obama administration in the US recently provided a large guaranteed loans to two green-tech companies, Solyndra ($500 million) and Tesla Motors ($465 million). While the latter is often glorified as a success story, the former failed miserably and became the latest example, used widely by both economists and the more popular treatment by the media, of government being unable to ‘pick
winners’. Indeed, the taxpayer picked up the bill (Wood, 2012), and complained. This suggests the need for such investments to be made in a portfolio approach with some of the upside gains covering the downside losses. That is, if the public sector is expected to fill in for the lack of private VC money going to early stage innovation, it should at least be able to benefit as private VC does from the wins. Otherwise, the funding for such investments cannot be secured.

Yet questions about risks and rewards depend on the underlying framework through which public investment is justified. In a market-shaping framework, does government deserve to retain equity more than in a market failure framework? Are taxes currently bringing back enough return to government budgets to fund high-risk investments that will probably fail? Using a portfolio approach to public investments (Rodrik, 2013) means being able to reap back a reward from the wins, in order to fund the losses and the next round. Such direct return-generating mechanisms must be explored, including retaining equity, golden share of the IPR, and income-contingent loans, among others (Mazzucato, 2013).

Sharing risks and rewards also requires making sure that private sector commitment to innovation increases not falls. As recently emphasised by an MIT report on the innovation economy, today’s capitalism is missing the kind of large company engagement of the sort that Xerox Parc and Bell Labs played in the past. In looking at the strengths and weaknesses of the US innovation system and the causes of relative decline of manufacturing in America, the study has strived to understand why the development of promising innovations are stalling or simply moving abroad before reaching commercial scale—a problem even more central to the UK economy. One of the reasons unveiled by the study is the fact that large private R&D centres – like Bell Labs, Xerox PARC and Alcoa Research Lab – have become a thing of the past in big corporations; they have mostly disappeared. Long-term basic and applied research is not part of the strategy of ‘Big Business’ anymore, as corporate R&D now focuses on short-term needs (MIT, 2013). Recent examples of extreme financialization of large corporations, in areas as different as pharmaceuticals, IT and energy, is putting the development of proper innovation eco-systems at risk (Lazonick and Mazzucato, 2013). Financialization is most evident with the amount of profits being used to boost share prices (and stock options hence executive pay) through activities like share-buybacks (Figure 6 shows how repurchases of their own shares by the Fortune 500 companies reached $3 trillion dollars in the last decade)—with the most worrying aspect the degree to which such expenditure has outpaced R&D. Part of getting the risk-reward balance right must thus consist not only of allowing the public sector to reap its deserved reward for winning investments (to cover the inevitable losses, and the next round of investments) but also to increase the actual risks taken by large companies in the innovation process. This means that innovation policy and policies around financial reform and corporate governance should be brought together so the eco-systems of innovation (and associated private-public partnerships) that we build are more symbiotic and less parasitic.
6. CONCLUSION

This paper has considered the limitations of the market failure framework that continues to guide innovation policy. It has argued that putting innovation at the centre of growth policy requires an emphasis on shaping and creating markets not only fixing them. To facilitate this change—the goal of this think piece—the paper has considered insights from alternative (heterodox) literatures in the economics of innovation on this market creation process.

Considering the need for government policy to ‘transform’, be catalytic, create and shape markets not just fix them, helps reframe the key questions of economic policy from static ones that worry about crowding out and picking winners to more dynamic ones that are constructive in forming the types of public–private interactions that can create new innovation and industrial landscapes. In this perspective, it is key for government to not just pick different technologies or sectors but ask what it wants from those sectors. In the same way that putting a man on the moon required many sectors to interact, the ‘green’ direction being debated today also requires all sectors to change. Green is not only about wind, solar and biofuels but also about new engines, new maintenance systems, new ways of thinking about product obsolescence (Mazzucato and Perez, 2014). This is not about prescribing specific technologies, but providing directions of change which bottom up solutions can then experiment around. As Stirling (2014, p.2) has recently put it: ‘The more demanding the innovation challenges like poverty, ill health or environmental damage, the greater becomes the importance of effective policy. This is not a question of “picking winners”—an uncertainty-shrouded dilemma which is anyhow equally shared between public, private and third sectors. Instead, it is about engaging widely across society, in order to build the most fruitful conditions for deciding what “winning” even means’.

It has been argued here that government would benefit from adopting a portfolio approach to public investments in innovations, nurturing the explorative, plural, and trial and error aspect of change. This requires thinking not only about technological change in a new way but also organizational change. Building the public agencies of the future with creative, adaptive and explorative capacity.

In sum, this paper has argued that to approach the innovation challenge of the future, we must open up the discussion, away from the narrow worry about ‘picking winners’ and ‘crowding out’, towards a broader focus on four interlinked dynamic questions:
• **Directions.** How can public policy be understood in terms of setting the direction and route of change; that is, shaping and creating markets rather than just fixing them? What can be learned from the ways in which directions were set in the past, and how can we stimulate more democratic debate about such directionality?

• **Evaluation.** How can an alternative conceptualisation (to standard market failure theory) of the role of the public sector in the economy translate into new indicators and assessment tools for evaluating public policies, beyond the micro-economic cost/benefit analysis? How does this alter the crowding in/out narrative?

• **Organisational change.** How should public organisations be structured so they accommodate the risk-taking and explorative capacity, and the capabilities needed to envision and manage contemporary challenges?

• **Risks and Rewards.** How can this alternative conceptualisation be put into practice so that it frames investment tools so that they not only socialise risk but also have potential to socialise the rewards that enable ‘smart growth’ to also be ‘inclusive growth’?
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