Challenge-Driven Innovation Policy: Towards a New Policy Toolkit

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Abstract

Policy makers are increasingly embracing the idea of using industrial and innovation policy to tackle the 'grand challenges' facing modern societies. This article argues that through well-defined goals, or more specifically 'missions', that are focused on solving important societal challenges, policymakers have the opportunity to determine the *direction* of growth by making strategic investments across many different sectors and nurturing new industrial landscapes, which the private sector can develop further, and as a result induce cross-sectoral learning and increase macroeconomic stability. This 'mission-oriented' approach to industrial policy is not about 'top down' planning by an overbearing state; it is about providing a direction for growth and increasing business expectations about future growth areas and catalysing activity that otherwise would not happen. It is not about de-risking and levelling the playing field, nor about supporting more competitive sectors over less since the market does not always 'know best' but tilting the playing field in the direction of the desired societal goals, such as the sustainable development goals. To achieve this requires a different policy framework, what we call the 'ROAR' framework, which involves strategic thinking about the desired direction of travel (*Routes*), the structure and capacity of public sector *Organisations*, the way in which policy is *Assessed* and the incentive structure for both private and public sectors (*Risks and Rewards*). The article argues that if we want to take grand challenges such as the SDGs seriously as policy goals, market shaping should become the overarching approach followed in various policy fields.

Keywords Mission-oriented innovation policy · Market shaping · Dynamic spillovers

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1 Introduction

Policy makers are increasingly embracing the idea of using industrial and innovation policy to tackle the 'grand challenges' facing modern societies. Examples of challenge-led policy frameworks include the United Nation's sustainable development goals (SDGs; Borras 2019), the European Union Horizon 2020 research and development programme (Mazzucato 2018a), the WWWforEurope project (Aiginger 2016) and the UK's 2017 Industrial Strategy White Paper (HM Government 2018).

Challenge led policies require confronting the direction of growth—growth that is for example more inclusive and sustainable. But this is very hard to do within the traditional framework that sees policy as simply fixing market failures, and at best as facilitating value creation. We believe challenge led growth requires a new tool kit. One that is more based on market shaping and market co-creating (Mazzucato 2016). This is both a question of theory as well as policy practice. In theory, challenge-driven innovation policy questions both established neoclassical as well evolutionary concepts (Schot and Steinmueller 2018). In policy practice, directed policies require rethinking what is meant by vertical policies. Industrial policies have always been composed of both a horizontal and a vertical element. Horizontal policies have historically been focussed on skills, infrastructure, and education, while 'vertical' policies have focussed on sectors like transport, health or energy, or technologies. These two traditional approaches roughly embody differing schools of economics: neoclassical economics inspired horizontal policies focusing on supply side factors and inputs; and evolutionary economics inspired policies putting emphasis on demand side factors and systemic interactions (Nelson and Winter 1974; and Hausmann and Rodrik 2006 for a synthesis).

Although certain sectors might be more suited for sector-specific vertical strategies, the 'grand challenges' expressed in SDGs are cross-sectoral by nature, and hence, we cannot simply apply vertical approach to such challenges. The idea of structural renewal through directing innovation has found perhaps the most original expression in Albert Hirschman's idea of development through unbalanced growth (1958). Hirschman argued that consciously keeping development unbalanced, meaning letting some economic activities develop faster than others, keeps development momentum going as it enforces cross-sectoral learning and experimentation. Given that firms often base their investments on the perception of future growth opportunities, vertical or 'unbalanced growth' policies can help to drive future business investment (Dosi and Lovallo 2007) and, as Hirschman argued, induce cross-sectoral positive feedback loops. In this view, innovations are economy-wide learning and self-discovery processes that help companies hedge their balance sheets and provide analytical linkages between macroeconomic financial stability and microeconomic firm behaviour (Minsky 1982: 22–29). If firms are confident about future technological and market opportunities, they will invest and seek to innovate, and if they are not confident, or see few market opportunities, they will not invest or innovate (Schumpeter 1983). Therefore, any industrial strategy should not only seek to improve the conditions under which firms invest, but also aim to stimulate demand and increase business expectations about where future growth opportunities might lie.

In this article, we argue that through well-defined goals, or more specifically 'missions', that are focused on solving important societal challenges, policymakers have the opportunity to determine the *direction* of growth by making strategic investments across many different sectors and nurturing new industrial landscapes, which the private sector can develop further (Mazzucato 2017; Mazzucato and Penna 2016), and as a result induce cross-sectoral learning

and increase macroeconomic stability. This 'mission-oriented' approach to industrial policy is not about 'top down' planning by an overbearing state; it is about providing a direction for growth and increasing business expectations about future growth areas and catalysing activity—self-discovery by firms (Hausmann and Rodrik 2003)—that otherwise would not happen (Mazzucato and Perez 2015). It is not about de-risking and levelling the playing field, nor about supporting more competitive sectors over less (Aghion et al. 2015) since the market does not always 'know best' but tilting the playing field in the direction of the desired societal goals, such as the SDGs.

To achieve this requires a different policy framework, what we call the 'ROAR' framework, which involves strategic thinking about the desired direction of travel (*Routes*), the structure and capacity of public sector *Organisations*, the way in which policy is *Assessed* and the incentive structure for both private and public sectors (*Risks and Rewards*). Such an approach goes beyond the traditional 'market failure' framework derived from neoclassical welfare economics to a 'market co-creating' and 'market-shaping' role (Mazzucato 2016). Indeed, we argue that if we want to take grand challenges such as the SDGs seriously as policy goals, market shaping should become the over-arching approach followed in various policy fields.

1.1 From Market Failure to Market Shaping: Introducing ROAR Policy Framework

The dominant approach to public policy is derived from neoclassical economic theory, in particular microeconomic theory and welfare economics. This approach emphasises the idea that, given certain assumptions, individuals pursuing their own self-interest in competitive markets gives rise to the most efficient outcomes (Samuelson 1947; Mas-Colell et al. 1995: 539-40). Efficiency is understood in a utilitarian sense, whereby an activity is efficient if it enhances someone's welfare without making anyone else worse off (so-called Pareto efficiency). Under these conditions, the role of government intervention is in practice often limited to addressing instances where the market is unable to deliver Pareto-efficient outcomes.

Such 'market failures' arise when there are information asymmetries, transaction costs and frictions to smooth exchange, or non-competitive markets (e.g. monopolies) or externalities, whereby an activity harms another agent not directly connected with the market transaction (e.g. pollution), or coordination and information failures hampering investment (Rodrik 1996).

In the 1960s, 'public choice' theory considered how the actions of agents (voters, bureaucrats, politicians) involved in policy could be considered from an economic efficiency perspective, whereby those agents, including government agents, were assumed to be self-interested (Buchanan and Tullock 1964). While in markets the existence of competition and the profit motive tends to enforce efficient decision-making, in collective decision-making processes (i.e. politics and public administration) the same disciplining framework does not exist. Policy making is thus subject to capture by certain interest groups, in particular those most able to influence policy makers due to reasons of power or money. This is particularly the case because rational voters have little reason to take an interest in political decisions since most voting decisions have only a very tiny impact on the voters' lives: the 'problem of collective action' (Olson 1965). In public administration, the lack of competitive pressures leads to 'bureau-maximising' behaviour, whereby departments and agencies look after their own survival rather than the 'common good'.

Public choice theory argues that even where there are clear examples of market failure, it is not always the case that government intervention would result in a more efficient outcome. Rather, there could also be 'government failure', whereby decisions aimed at improving

welfare make things even worse than they would have been under conditions of market failure (Le Grand 1991). For policy design and evaluation, such an approach creates a bias towards inaction. If the default assumption is that the market will find the best outcome, even if it does not the overriding concern is that government intervention may worsen existing outcomes and the default prescription for government policy is to maintain the status quo. There is a danger that analytical frameworks become focused more on justifying and measuring the non-failure of public policies rather than the attainment of wider policy goals.

In policy practice, the market failure perspective also creates a particular orientation towards innovation, industrial policy and structural economic change.[1] While certain elements of innovation policy, in particular early-stage R&D, can be considered to be public goods and thus a case for public policy provision can be justified, in the main it is assumed that the private sector is the more efficient innovator, possessing greater entrepreneurial capacity and better able to take risks given the pressure created by competition. In contrast, the state is viewed as risk-averse and in danger of creating government failure if it becomes too involved in industrial policy by 'picking winners'. Its role is to level the playing field for commercial actors—mostly through supply-side inputs such as better skills or the removal of market frictions—and then get out of the way. This is has led to rather diverse debates and development of policy evaluation practices aimed at finding ever more precise *policy targets* through better measuring of failures and of the impact of policies trying to fix those failures. Instead, particularly policy discussions should focus on 'heterodox' policy approaches that recognise both market and government imperfections and failures—and also the fact that it is impossible or even undesirable to attempt to remove all of them at once—and the need for policies that support scale economies, dynamic learning effects, and cross-sectoral spillovers (Rodrik 2009).

At the macroeconomic level, the market failure approach argues for limiting the role of the state to mitigating the impact of the natural business cycle generated by free market economies, so fiscal and monetary policy should be limited to countercyclical interventions via adjustments to public spending, taxation and interest rates. To prevent these policies becoming subject to government failure, an externally imposed rules-based framework is advisable, with discretionary interventions undesirable (Blinder 2004). Thus, fiscal policy is constrained by the 'discipline' of budget deficit targets, and central banks are limited by tight mandates oriented towards price stability above and beyond other goals and are operationally independent of governments and thus 'political capture'.

In particular, by the 1980s, public choice theory and welfare economics became the dominant approach to policy. Importantly, it gave rise to a culture of impact assessment that relied on cost-benefit analysis, productivity measurements and various indicators, indexes and ranking systems to measure policy success or failure (Kattel et al. 2013).

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[1] It should be noted that some eminent economists have rejected the market failure justification for policy intervention since the concept that markets by themselves lead to efficient outcomes is dependent on conditions—perfect information, completeness, no transaction costs or frictions—that have never been empirically demonstrated (Coase 1960; Stiglitz 2010). Rather, markets are *always* incomplete and imperfect, and hence not 'constrained Pareto-efficient', i.e. they are never in a situation where a government (a central planner) may not be able to improve upon a decentralised market outcome, even if that outcome is inefficient (Greenwald & Stiglitz 1986). As already shown by Kenneth Arrow (1962: 623), while a market failure approach can be utilised to understand why private firms underinvest in R&D, it is not so useful in guiding public investment in R&D because of the inherent uncertainty involved in the outcomes from such investment. Indeed, Arrow called for alternative approaches to analysing public investment and policies for innovation.

However, the first key problem that any framework that focuses on policy only in terms of fixing problems, especially (but not only) market failures, does not embody any explicit justification for the kind of market creation and mission-oriented *routes* of directionality that was required for innovations such as the Internet and nanotechnology and is required today to address societal challenges (Mazzucato 2016). Secondly, by not considering the state as a lead investor and market creator, such failure-based approaches do not provide insights into the type and structure of public sector *organisations* that are needed in order to provide the depth and breadth of high-risk investments. Thirdly, as long as policy is seen only as an 'intervention', rather than a key part of the market creation and shaping process, the type of *assessment* criteria used to assess public investments will inevitably be problematic. Fourthly, by not describing the state as a lead risk-taker and investor in this process, the failure-based approaches have avoided a key issue regarding the distribution of *risks and rewards* between the state and the private sector.

Thus, a policy framework for market shaping activities by the public sector should offer answers to the following questions (*ROAR*):

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 (Routes of directionality)?
2. How should public organisations be structured so they accommodate the risk-taking, explorative capacity and capabilities needed to envision and manage contemporary challenges (Organisations)?
3. How can this alternative conceptualisation be translated into new dynamic indicators and evaluation tools for public policies, beyond the static micro-economic cost/benefit analysis and macroeconomic appraisal of crowding in/crowding out that stem directly from the market failure perspective (Assessment)?
4. How can public investments along the innovation chain result not only 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 potential *connection and internal coherence* that can help build a *market creation* policy framework—and practical toolkit. Policies that aim to actively create and shape markets require indicators that assess and measure the performance of a policy along that particular transformational objective. The state's ability and willingness to take risks, embodied in transformational changes, requires an organisational culture and dynamic capabilities that welcome the possibility of failure and experimentation and is rewarded for successes so that failures (which are learning opportunities) can be covered and the next round financed.

The ROAR framework assumes a synthetic approach to public value that is *collectively* generated by a range of stakeholders, including the private sector, the state and civil society. The market and the economy itself, under this approach, are viewed as an *outcome* of the interactions between these sectors, following Karl Polanyi's (1944) notion of the 'embeddedness' of the economy in society and culture. This 'collective public value' approach also has roots in classical political economy where the notion of 'value' was actively debated rather than assumed to be tied to market exchange. Thinkers such as Ricardo, Mill and even Adam Smith recognised that unfettered markets were often inefficient, prone to capture by special interests and could have negative distributional outcomes without ongoing intervention by the state. In particular, these thinkers recognised a distinction between productive *profits*

and economic *rents* that represented unearned income deriving from arbitrary control over resources (Mazzucato 2018b; Ryan-Collins et al. 2017).

Public value in this conception builds on the idea of markets as embedded in society and on a public purpose-focused service approach in the public administration and strategic design literatures and practice. Public purpose(s) would include cultural enrichment a more even distribution of wealth and income, ecological sustainability, affordable shelter and health care and the creation of good quality jobs. These may sound somewhat obvious, but it is clear that modern capitalist markets not guided by such purposes are not delivering them effectively (Jacobs and Mazzucato 2017).

1.2 R: Routes and Directionality—a Mission-Oriented Approach

A key success of past market shaping innovation policies, such as mission-oriented policies of the Moon-shot era, has been to set a clear direction for problems to be solved (e.g. going to the moon and back in one generation) that then required cross-sectoral investments and multiple bottom-up solutions, of which some inevitably fail. Too much top-down can stifle innovation and too much bottom-up can make it dispersive with little impact.

In crucial difference to classical 'Moon-shot' type mission-oriented policies of the cold war era, modern missions are focusing on areas such as managing the impact of technological advance and artificial intelligence on the labour market; adapting to changing demographics and an ageing population; or making the transition to a low carbon economy (European Commission 2011; Kattel and Mazzucato 2018). Taking up the challenge posed by Richard Nelson in his seminal *Moon and the Ghetto* (1977), modern day mission-oriented policies focus not on technological challenges alone but rather on areas traditionally falling under public services such as education or welfare state, and entail changes across various economic and policy sectors. Germany's *Energiewende* policy, for instance, aims to combat climate change, phase-out nuclear power, improve energy security by substituting imported fossil fuel with renewable sources, and increase energy efficiency. By providing a direction to technical change and growth across different sectors, *Energiewende* is tilting the playing field in the direction of a desired *socio-economic* goal. Importantly, it is not just about growing 'green sectors'—it has required many sectors, including traditional ones such as steel, to transform themselves, and leads to changes in patterns of production, services and consumption of energy. In other words, its spillovers are as much technological, social and behavioural (Fagerberg 2018 for a discussion).

The policies tackling grand challenges should thus be broad enough to engage the public, enable concrete missions, attract cross-sectoral investment, and remain focussed enough to involve industry and achieve measurable success. By setting the direction for a solution, missions do not specify how to achieve success. Rather, they stimulate the development of a range of different solutions to achieve the objective, i.e. missions guide entrepreneurial self-discovery (Foray 2018). As such, a mission can make a significant and concrete contribution to meeting a SDG or grand challenge.

The criteria for selecting missions, adopted by the European Commission after the "Missions report" (Mazzucato, 2018b) was used for wide stakeholder consultation, is that they should:

- be bold and address societal value
- have concrete targets: you know when you got there!

- involve research and innovation: technological readiness over limited time frame
- be cross-sectoral, cross-actor, cross disciplinary
- involve multiple competing solutions and bottom up experimentation

To illustrate, take SDG 14: 'Conserve and sustainably use the oceans, seas and marine resources for sustainable development'. This could be broken down into various missions, for example 'A plastic-free ocean' (Fig. 1). This could stimulate research and innovation in methods for clearing plastic waste from oceans or in reducing the use of plastics, innovation in new materials, research on health impacts from micro-plastics, behavioural research and innovation to improve recycling or drive public engagement in cleaning up beaches. Each of these areas can be broken down into particular 'projects'.

The market-shaping, mission-oriented approach to policy cuts through the problematic state-market dichotomy that dominates much discussion on economic efficiency and value, with its origins in the market failure theory and its critique. Market shaping is not only about public investment strategy, but also needs to include the wider institutional features of markets, from the regulatory framework (e.g. environmental standards) to the supply of skills, to the creation of demand for new products and services (e.g. through procurement).
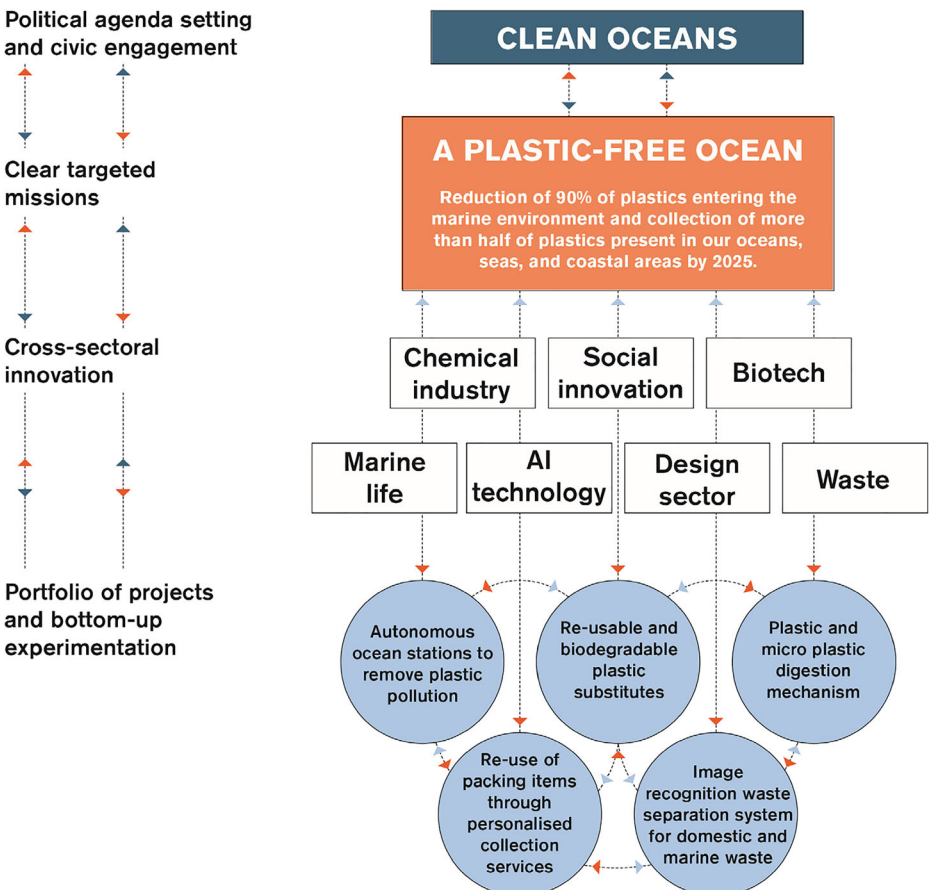

Fig. 1 A mission-oriented approach to cleaning the oceans. Source: Mazzucato (2018c: 24)

1.3 O: Organisational Capabilities in the Public Sector

A key concern should be to establish skills/resources, capabilities and structures that can increase the chances that a public organisation will be effective, both at *learning* and at *establishing symbiotic partnerships with the private sector*, and ultimately succeed in implementing mission-oriented and transformative policies. Public and private organisations must re-rethink their roles when working together. Public–private partnerships have often limited the public part to de-risking the private part. This ignores the capabilities and challenges involved in public sector risk-taking. De-risking assumes a conservative strategy that minimises the risks of picking losing projects, but does not necessarily maximise the probability of picking winners, which requires the adoption of a portfolio approach for public investments (Rodrik 2014). In such an approach, the success of a few projects can cover the losses from many projects, and the public organisation in question also learns from its loss-making investments (Mazzucato 2013). Here, the matching between failures and fixes is less important than having an institutional structure that ensures that winning policies provide enough rewards to cover the losses, and that losses are used as lessons to improve and renew future policies.

One can argue that the community of Schumpeterian scholars never followed up the call by Nelson and Winter (1982) for public policy to be matched by bold new organisational structures in the public sector: "The design of a good policy is, to a considerable extent, the design of an organizational structure capable of learning and of adjusting behavior in response to what is learned." (384) Indeed, there is no equivalent in the literature to 'dynamic capabilities of the firm' for the public sector. The developmental state research looking at the success of East Asian tigers argued that public sector capacities and capabilities can be best developed by talent recruited and motivated via *Weberian means* of *meritocratic recruitment* and *career management* to make working for government either financially competitive and/or culturally even more rewarding/prestigious than working in the private sector. Evans and Rauch (1999) cemented these ideas through a quantitative analysis that tested the importance of some of the 'Weberian' elements (merit-based recruitment and career systems) on a much broader sample of countries as a whole (see also Rauch and Evans 2000; Evans 1998). This is best captured by Chalmers Johnson and his concept of *developmental state*: a country with predominant policy orientation towards development supported by small and inexpensive elite bureaucracy centred around a pilot organisation, such as the Ministry of International Trade and Industry (MITI) in Japan, with sufficient autonomy (limited intervention by the legislative and judiciary) (Johnson 1982: 305–320).

What is missing, however, in the Weberian framework of capacities are the evolutionary dynamics: why do specific constellations of capacities become more successful than others?

Teece and Pisano define dynamic capabilities of the firm through their evolutionary nature: "The term 'dynamic' refers to the shifting character of the environment; certain strategic responses are required when time-to-market and timing is critical, the pace of innovation accelerating, and the nature of future competition and markets difficult to determine. The term 'capabilities' emphasizes the key role of strategic management in appropriately adapting, integrating, and re-configuring internal and external organizational skills, resources, and functional competencies toward changing environment." (1994: 1) We argue that challenge-driven public policies need to be based on a similarly evolutionary understanding of capabilities in the public sector.

In order to tackle the grand challenges of the twenty-first century, innovation policy needs to shift from the existing support-and-measure approach (find market failure; fix it with a support instrument; measure the impact) to innovation policy to lead-and-learn approach (create and shape markets with variety of policy instruments with open-ended impact horizons, and learn through wider social engagement and coordination). And we propose that twenty-first-century missions require following set of dynamic capabilities in the public sector in order to engender mission-oriented policies (Kattel and Mazzucato 2018):

First, key to our premise is that grand challenges can only be solved through dynamic public-private partnerships, but these have been constrained by the notion of public actors as at best fixing markets. A market co-creating role requires the state to have capabilities for leadership and engagement: missions can all too quickly become either just fashionable labels on 'business-as-usual' practices or too rigid top-down planning exercises. Thus, capabilities to engage with a wide set of social actors, to show leadership through bold vision are vital in times with high 'democratic deficit' in many developed countries (See also ESIR 2017) Some of the grand challenges contest 'the way of life' as we know it (e.g. suburbanisation accompanied by congested transportation systems). Capabilities to encourage bottom-up engagement mean that there is a capacity to set mission but also to leave enough space for contestation and adaptability.

Second, on the level of policy, the ability to find coherent policy mixes (instruments and funding) and capabilities of coordination seem fundamental to the success of today's mission-oriented policies. As today's missions are not just about technological solutions but include strong socio-political aspects, experimentation capabilities matter perhaps more than before. Equally important are evaluation capabilities that do not rely only on market failure based approaches (e.g., cost-benefit analysis) but can integrate user research, social experiments and system level reflection (Lindner et al. 2016; Rip 2006).

Third, administrative capabilities need to rely on diversity of expertise and skills, from engineering to human-centric design, organisational forms to mix unrelated knowledge areas (e.g. in urban mobility and planning, lifestyles matter as much as do new energy storage systems; see Grillitsch et al. 2017), and organisational fluidity (e.g. cross-departmental teams) seem to be fundamental for managing new missions (OECD 2017).

1.4 A: Assessment and Evaluation

One of the key challenges in applying a public value-based framework in policy making is how to relate it to budgetary processes. Current public policy discussions tend to start from existing fiscal constraints (how can we pay for it?) rather than from policy goals and desired outcomes (Kelton 2011). Typically, as discussed above, governments attempt to discipline spending by adopting fiscal frameworks that target a certain ratio of borrowing relative to previous years or to current GDP. This approach neglects two important facts. Firstly, deficit spending may have economic multiplier effects that enable growth to increase at a faster rate than borrowing, hence reducing the debt-to-GDP ratio; and, secondly, unlike households or firms, governments with sovereign currencies and central banks cannot become bankrupt since ultimately they are the currency issuer rather than taker, as with the private sector (Wray 2015).[2]

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[2] Although in modern economies central banks are generally prohibited from directly financing governments, a central bank can always ensure a market for sovereign currency-denominated government debt at a desired rate of interest since there are no limits to the quantity of such debt it can purchase via money creation on secondary markets (Terzi 2014).

Given this, a more coherent framework for government spending—not least in regard to market shaping, mission-oriented policies—is the 'functional finance' approach whereby fiscal policy is focused on achieving desired public purpose outcomes (e.g. full employment at stable prices)—or missions—unconstrained by considerations over the relative size of the government deficit (Lerner 1943). The latter should instead be viewed as an indicator of where in the economy demand is coming from. This will fluctuate depending on the confidence of the private sector and the business and financial cycle. This is not to say that the inflation should be ignored—clearly at certain times an economy may run in to capacity constraints reflected in rising prices which may require cutting spending or raising taxes—but it is to say budget deficits should have less prominent role in fiscal policy decisions.

Influenced by the market failure framework, constraint-driven budgetary processes are complemented by policy design and appraisal techniques that are usually based upon a notion of allocative efficiency and some form of *ex-ante* cost-benefit analysis (CBA). Costs (including the costs of potential government failure) are usually defined by their opportunity cost, i.e. the value which reflects the best alternative use a good or service could be put to (include a do-nothing/business as usual option), with all else (including all other prices) assumed equal, and with market prices usually the starting point for the analysis (HM Treasury 2018: 6).[3] Policy evaluation, after the policy intervention, then seeks to verify whether the estimates were correct and whether the market failure was addressed.

To enable market-type price comparison of interventions whose return will vary in terms of time, CBAs typically make use of a 'discount rate' that reflects the time preference of users of the service for having money now rather than in the future. After adjusting for inflation and discounting, costs and benefits can be added together to calculate the net present value (NPV) for different policy options. Recognising the problem of externalities, some attempt has been made in recent years to incorporate the wider costs to society of particular policy actions, e.g. through monetising certain social or ecological externalities in a 'social cost benefit analysis' (SCBA) or 'social cost effectiveness analysis' (SCEA). However, the overall framework remains rooted in the idea that creating a 'market price' for interventions will enable the most accurate decision to maximise welfare and public value. CBA and NPV are mostly aimed at *preventing* costly government failures; by their very nature, they cannot tell us very much at all about *proactive* market creating and shaping.

This limitation is of crucial importance. Market-shaping policies, such as missions, aim to accelerate innovation, creating new technologies and radically changing the prices, availability and existence of goods and services. Their central purpose is to transform underlying relationships, a wide range of prices and the broader environment (OECD 2015). The 'all else (including prices) being equal' assumption underlying cost-benefit analysis becomes problematic in such circumstances.

By always comparing the policy intervention to the status quo and emphasizing short-term risks, CBA approaches encourage decision-makers to prefer small-scale, marginal interventions (Allas 2014: 89). Yet there is considerable evidence that innovation systems exhibit increasing returns or an 'S-curve'-type effect, where shifting incentives across multiple sectors may be more likely to achieve such increasing returns (Mazzucato 2017). So, arguably, if there

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[3] We refer in this section to the UK's *The Green Book: Central Government Guidance on Appraisal and Evaluation* (HM Treasury 2018) to provide illustrative examples of the market failure analytical framework. There will, of course, be variation across countries, but *The Green Book* is widely recognised as one of the leading appraisal and evaluation guidance manuals in the field, adopted by many other governments.

is to be any bias around innovation policy, it should be *in favour* of large-scale interventions. Furthermore, the strong emphasis on risk assessment/optimism bias is likely to mitigate against the creation of a mission-orientated approach where failure is viewed as a learning process integral to the achievement of important technological breakthroughs (Mazzucato 2013).

More broadly, budget-constrained, CBA-type analyses derived from market failure theory are concerned with allocative or distributive efficiency, which involves making the best use of (fixed) resources at a fixed point in time. Dynamic efficiency involves making the best use of resources to achieve changes over time and so is concerned with innovation, investment, improvement and growth—including, perhaps most importantly, the creation of new resources (technologies) and shifting technology frontiers (De Soto 2009; Kattel et al. 2018).[4] 'Decarbonisation at least cost' (or 'at most gain') is an example of a dynamic efficiency objective. Missions are, by definition, concerned with dynamic efficiency, since they aim to accelerate innovation and transformational change.

When allocative efficiency frameworks are applied to dynamic efficiency problems, the analysis risks are either irrelevant or actively unhelpful.[5]

Aside from considerations of efficiency, given the importance of dynamics over time for market-shaping policies, it is important to define a concrete target and objectives. In other words, it must be possible to say definitively whether the policy has been achieved or not. Technological missions such as 'putting a man on the moon' had obvious end points which made evaluation easier. However, modern grand challenges are more long term with less easy to define end points.

1.5 R: Risks and Rewards[6]

But this then raises a more fundamental question: how to make sure that, like private venture capital funds, the state can reap some return from the successes (the 'upside'), in order to cover the inevitable losses (the 'downside') and finance the next round of investments. This is especially important given the path-dependent and cumulative nature of innovation. Returns arise slowly; they are negative in the beginning and gradually build up, potentially generating huge rewards after decades of investment. Indeed companies in areas like ICT, biotechnology, and nanotechnology had to accept many years of zero profits before any returns were in sight. If the collective process of innovation is not properly recognised, the result will be a narrow group of private corporations and investors reaping the full returns of projects which the state helped to initiate and finance.

So who gets the reward for innovation? Some economists argue that returns accrue to the public sector through the knowledge spillovers that are created (new knowledge that can

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[4] There is no single universally agreed definition of dynamic efficiency. However, the concept has a long history in economic thought, and a wide range of sources agree that it relates to the capacity of the economy for innovation, growth and effective change over time (De Soto 2009). It can also describe the efficiency of policy measures in achieving these effects. One definition that goes against this consensus involves achieving an 'optimum' balance between short-term and long-term economic interests (Abel et al. 1989). For our purposes, this definition should be rejected, since a) it is in fact allocative efficiency by another name; and b) under conditions of uncertainty where there is no known finite range of possibilities, the concept of 'optimality' is meaningless (Arthur 2014).

[5] This point is recognized in the literature. de Soto (2009) writes: 'dynamic efficiency analysis makes it possible to perform an evaluation which leads to a much clearer and in many cases much different position than the one which usually follows from a mere static efficiency analysis.'

[6] This section is based on Mazzucato 2018c.

benefit various areas of the economy), and via the taxation system due to new jobs being generated, as well as taxes being paid by companies benefiting from the investments. But the evolution of the patenting system has made it easier to take out patents on upstream research, meaning that knowledge dissemination can effectively be blocked and spillovers cannot be assumed. The cumulative nature of innovation, and the dynamic returns to scale (Nelson and Winter 1982), means that countries stand to gain significantly from being first in the development of new technologies.

At the same time the global movement of capital means that the particular country or region funding initial investments in innovation is by no means guaranteed to reap all the wider economic benefits, such as those relating to employment or taxation. Indeed, corporate taxation has been falling globally, and corporate tax avoidance and evasion rising. Some of the technology companies which have benefited the most from public support, such as Apple and Google, have also been among those accused of using their international operations to avoid paying tax (Johnston 2014). Perhaps most importantly, while the spillovers that occur from upstream "basic" investments, such education and research, should not be thought of as needing to earn a direct return for the state, downstream investments targeted at specific companies and technologies are qualitatively different. Precisely because some investments in firms and technologies will fail, the state should treat these investments as a portfolio, and enable some of the upside success to cover the downside risk.

In particular, there is a strong case for arguing that, where technological breakthroughs have occurred as a result of targeted state interventions benefiting specific companies, the state should reap some of the financial rewards over time by retaining ownership of a small proportion of the intellectual property it had a hand in creating. This is not to say that the state should ever have exclusive licence or hold a large enough proportion of the value of an innovation to deter its diffusion (and this is almost never the case). The role of government is not to run commercial enterprises; it is to spark innovation elsewhere. But by owning some of the value it has created, which over time has the potential for significant growth, funds can be generated for reinvestment into new potential innovations. By adopting a "portfolio" approach to public investments in innovation, success from a few projects can then help cover the losses from other projects. In this way, both risks and rewards are socialised (Mazzucato 2016).

There are many examples of public organisations that have strategically considered the distribution of risks and rewards. At times, they have granted licences to private firms willing to invest in up-grading publicly owned technologies, offering the opportunity for public and private to share risks and also the rewards. For example, NASA has sometimes captured the returns to its inventions, whilst private partners gained on the value-added in case of successful commercialisation (Kempf 1995). Further there are examples of state-owned venture capital activity generating royalties from public investments (in Israel, see Avnimelech 2009) or equity (in Finland via Sitra), and the more pervasive use of equity by state development banks (e.g. in Brazil, China and Germany, see Mazzucato and Penna 2016).

Policy instruments for tackling risk-reward issues combine supply and demand-side mechanisms, geared to enabling public value creation through symbiotic public-private partnerships ("active") (Lazonick & Mazzucato 2013) and blocking value extraction ("defensive").

The different mechanisms to distribute rewards can be done either directly through profit sharing (via equity, royalties) or indirectly through conditions attached, focussed more on the market shaping role. The latter may involve conditions on reinvestment of profits, conditions on pricing, or conditions on the way that knowledge is governed.

This list is not meant to be exhaustive, but rather, to illustrate that there are multiple experiences in handling policy instruments that, implicit or explicitly, permit to take account of issues like value extraction and enabling government to capture a share of the value it helped to generate. The latter, in particular, have been adopted by different types of agencies, at different stages of the innovation chain but mainly downstream, involving different types of partners (e.g. firm size) and industries. However, not always have they been adjusted to the specificities of different economic, industrial and legal settings. Absent a framework that more clearly informs these policies, decisions on these matters have sometimes been made unintentionally and haphazardly, inviting both government and systemic failures.

The prospect of the state owning a stake in a private corporation may be anathema to many parts of the capitalist world, but given that governments are already investing in the private sector, they may as well earn a return on those investments (something even fiscal conservatives might find attractive). The state need not hold a controlling stake, but it could hold equity in the form of preferred stocks that get priority in receiving dividends. The returns could be used to fund future innovation (Rodrik 2014). Politicians and the media have been too quick to criticise public investments when things go wrong, and too slow to reward them when things go right.

Thus, rather than worrying so much about the "picking winners" problem, more thinking is needed about how to reward the winning investments so they can both cover some of the eventual losses (which are inevitable in the innovation game), and also raise funds for future investments. This can be done by, first, getting the tax system to work more effectively to support innovation, and, second, considering other mechanisms which allow the state to reap a direct reward in those cases when it is making specific bets on companies. If all fails, the taxpayer picks up the bill. But when it goes well, the taxpayer gets rewarded.

Going hand in hand with this consideration is the need to rethink how public investments are accounted for in the national income accounting. Investments in innovation are different to current expenditures. The latter does not add to balance-sheet assets; the former does and is potentially productive investment in the sense that it creates new value (Mazzucato and Shipman 2014). When setting limits to fiscal deficits, it is therefore necessary to distinguish public debt contracted for investment in R&D and infrastructure (value-creating investments) from public debt contracted for (public or private) consumption. In this sense, financial and accounting reforms should be regarded as a prerequisite for any successful smart and inclusive growth plan.

Finally, considering the role of government as lead risk-taker helps to debunk fundamental assumptions behind the theory of shareholder value, which underpins the exorbitant rewards earned by senior executives in recent years. Pay via stock options has been a key feature of modern capitalism, and especially a key driver of the inequality between the top 1% of income earners and the rest (Piketty 2014). Stock options are boosted when stock prices rise, and prices often rise through 'financialised' practices such as share repurchase schemes by companies (Lazonick 2014). Focusing on boosting share prices is justified on the grounds of the theory of shareholder value, which holds that shareholders are the biggest risk-takers in a company because they have no guaranteed rate of return (while workers earn set salaries, banks earn set interest rates, etc.). That is, they are the residual claimants (Jensen 1986).

But this assumes that other agents do have a guaranteed rate of return. As we have argued throughout the paper, precisely because what the state does is not just facilitate and de-risk the private sector, but also take major risks, there is no guarantee of success in its investments, which have historically also played a crucial role in enabling wealth creation. The fact that a key driver of inequality has been linked with a problematic understanding of which actors are the greatest risk-takers implies that combatting short-termism (Haldane 2016) and speculative

forms of corporate governance (Kay 2012) requires not only reforming finance and corporate governance, but also rethinking the models of wealth creation upon which they are based (Lazonick and Mazzucato 2012; Mazzucato 2018b).

2 Summary and Discussion

Market-shaping, mission-oriented approaches to policy give us the possibility to reconsider how to justify ambitious policies that aim to transform landscapes rather than fix problems in existing ones. This approach to policy raises challenges in regard to how to nurture organisational structures that can manage such policies, and how to appraise and evaluate the market-shaping effect of the policies. Rather than assessing the impact of policy based on budget-constrained, static, allocative efficiency measures, we have argued it should be focussed on dynamic efficiency and the creation of collective public value. This approach would help capture the potential for policy to create spillover effects across many sectors of the economy and alter the level of investment and broader trajectory of economic growth. A summary of the key elements of the market shaping analytical framework, comparing it with market fixing framework, is provided in Table 1.

We argue that theoretical and practical approaches to policy evaluation should be considerably enriched and diversified in order to create the capacities needed to deliver challenge-driven policies. Governments should embrace new tools and techniques from service design research that focus on user experience and co-creation practices, and from evolutionary economics and related disciplines that focus on shifting and shaping technology and innovation frontiers, and managing complex systems in contexts of uncertainty.

Table 1 Market fixing vs market-shaping policy frameworks

	Market fixing	Market shaping/mission-oriented
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
Business case appraisal	*Ex-ante* 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/monetisation of externalities/risk assessment; system is characterised by equilibrium behaviour	Future is uncertain because of potential for novelty and non-marginal 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. 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 et al. (2018)

What are some of the possible concerns with this type of approach? One concern is around the setting of missions and the direction of the market shaping in the first place. Clearly governments can and do become captured by particular interest groups which limit their ability to both establish missions and follow through on them. The challenges of climate change and inequality are obvious examples. Government subsidies continue to favour vested interests (for example fossil fuel energy firms) whilst taxation policy favours labour saving (increasing unemployment or underemployment) over resource saving (supporting decarbonisation) (Aiginger 2014), despite governments signing up to Treaties committing themselves to different policy directions. And of course democracy is no guarantee that societal missions—such as climate change—will be adopted globally as the current administrations in the USA and Brazil clearly demonstrate.

However, arguably these are the outcomes of governments not doing enough to shape markets to support social and ecological policy goals in the first place. Hopefully the ideas in this paper can help meeting that challenge.

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