CHAPTER II.4

MISSION-ORIENTED INNOVATION POLICY: CHALLENGES AND OPPORTUNITIES

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"We need to define [innovation] missions that breakdown silos... We need to set our eyes on a specific target, and drive our scientific efforts towards reaching that target. And we need to be ambitious about it. As Mariana Mazzucato says: 'Innovation-led growth is not just about fixing a market failure but also about setting direction and creating new markets. If you just tackle the market failure you can head into the wrong direction.' So we need to set direction for the future, and having a clear mission is a way of doing that."

(Speech by Carlos Moedas, EC Commissioner for Research, Science and Innovation, Brussels 15 May 2017[21])

21 https://ec.europa.eu/commission/commissioners/2014-2019/moedas/announcements/presentation-rise-group-publication-future-eu-research-and-innovation-policy-best-possible-future_en

1. Introduction

Countries around the world are seeking to achieve economic growth that is smart (innovation-led), inclusive and sustainable. Such ambitious goals require re-thinking the role of government and public policy in the economy. In particular, it requires a new justification of government intervention that goes beyond the usual one of simply fixing market failures. It also requires a new way to assess intervention so that dynamic system-wide spillovers are better captured.

This ambition to achieve a particular type of economic growth (smart, inclusive, sustainable) is a direct admission that economic growth has not only a **rate but also a *direction***. In this context, industrial and innovation strategies can be key pillars to achieving transformational change – in particular, identifying and articulating new *missions* that can galvanise production, distribution and consumption patterns across various sectors. Addressing such challenges – whether travelling to the moon, battling climate change or tackling modern care problems – requires investments by both private and public actors. The role of the public sector here is not just about de-risking, and levelling the playing field, but tilting the playing field in the direction of the desired goals. This includes making strategic decisions on the kind of finance that is needed, the types of innovative firms that will need extra support, the types of collaboration with other actors (in the third and private sector), and the types of regulations and taxes that can reward the desired behaviour. While public funding has always been important in the early, capital-intensive high-risk areas that the private sector tends to shy away from, modern-day missions can provide an even more fervent ground for an ambitious catalytic role for government in *creating and shaping markets* which provide the basis for private investment. Animal spirits are created not assumed.

From sectors to cross-sectoral solutions to concrete problems. Mission-oriented thinking requires understanding the difference between: (1) narrow sectors; (2) missions; and (3) broad challenges. a challenge is a broadly defined area which a nation may decide is a priority (whether through political leadership or the outcome of a movement in civil society). These may include areas like inequality, climate change or an ageing population. Missions involve tackling specific problems, such as reducing carbon emissions by x% over a specific period. Missions should be able to activate innovation across different sectors. For example, going to the moon required many different high-tech sectors (e.g. aerospace) and low-tech sectors (e.g. textiles) – and the process involved over 50 homework problems concerning different types of partnerships. Similarly, in Germany today, the *Energiewende* policy is a concrete mission with a specific reduction in carbon emissions over a specific period of time, aimed at tackling a broadly defined challenge (fighting climate change), which has required many different sectors to transform themselves. For example, steel in Germany has lowered its material content through repurpose, reuse and recycle strategies. While the man-on-the-moon mission was decided top down via political leadership, the German Energiewende policy was the fruit of bottom-up green movements, which culminated in political understanding and eventually leadership from above. Missions may require consensus building in civil society, and the need to set directions from above, with bottom-up experimentation processes from below.

1.1. Innovation at the centre of economic growth

As industrial policy is returning in many countries (e.g. after years of industrial policy being neglected, the UK's Prime Minister, Teresa May, formed a new department around it in 2016), a mission-based approach can help to ensure that industrial policy does not just end up being a static list of sectors to support. Rather, mission-oriented policies focus on creating system-wide transformation across many different sectors. The Apollo mission to the moon required high-tech and low-tech sectors to work together – and while the mission itself was top down, it was the bottom-up experimentation around many different 'homework problems' that galvanised the ensuing growth. In the same way, missions around sustainability and green growth will require many different sectors to rethink themselves and to work together in dynamic and interconnected ways. Among other things, this can lead to more 'additionality' in business investment, helping companies in different sectors to rethink themselves and make investments that would otherwise have not been made – which is extremely important in countries suffering from low business investment.

A *mission-oriented* approach means developing, implementing and monitoring a strategic innovation policy programme that draws on the strengths of an innovation system to overcome a country's weaknesses and address its challenges, seizing the opportunities offered by current capabilities and resources but especially the transformation of new capabilities and competencies. It requires putting innovation at the heart of economic growth policy – rendering the conversation between departments of finance and departments of innovation (or development) more horizontal and equitable, without the 'growth plans' (often driven by an assumed need to cut the deficit) to counteract the long-run innovation plans.

In this sense, it also means challenging economic policies that focus too much on short-term fiscal restraints, potentially damaging long-run growth opportunities. Investments in industrial transformation, R&D, human capital training and innovation take time. They involve high risks as there is no guarantee that the investment will pay off. But they are worth the wait as they are the key source of *productivity-enhancing*, creating well-paid jobs, with a higher multiplier effect than other types of governmental expenditure. Such investments can therefore help rebalance the public budget in the longer term by increasing future revenues. Thus, while the deficit might increase in the short term, the long-term debt/GDP is likely to fall. Such dynamic effects are often neglected in fiscal adjustment programmes.

Crucial to the implementation of a mission-oriented approach to innovation policy is the need to revitalise and reinvigorate capacity-building, competencies and expertise within the state (the *'developmental and networked' entrepreneurial state*, as referred to below). In this way, its different organisations can effectively fulfill their roles in coordinating and providing direction to private actors when formulating and implementing policies that address societal challenges through innovation (Mazzucato, 2016).

This scoping document outlines the challenges and opportunities of reviving industrial and innovation policies via a mission-oriented lens. It is meant to spark new thinking around the following specific areas:

- the possibilities of using **mission-oriented strategies** directed at solving concrete societal and/or technological challenges which catalyse innovation across a variety of sectors;
- the importance of a **systemic approach** to industrial and innovation strategies, and

the problems that can result when such an approach is lacking;

- the need to see industrial strategy as an **interaction between multiple actors** in both the public and private sectors;
- the need for public actors (decentralised networked entrepreneurial state state) to be positioned strategically along the **entire innovation curve** (e.g. not just upstream or downstream), including bold *demand-side* policies;
- ways in which industrial strategy can be used to **direct a green-growth agenda**;
- the role **public investment banks** can play in providing **patient long-term strategic finance** to high-risk and capital-intensive projects, ushering in future business investment.

2. Grand challenges and 'wicked problems'

The 21st century is becoming increasingly defined by the need to respond to major social, environmental and economic challenges. Sometimes referred to as 'grand challenges', these include environmental threats like climate change, demographic, health and well-being concerns, and the difficulties of generating sustainable and inclusive growth. The problems are 'wicked' in the sense that they are complex, systemic, interconnected and urgent, requiring insights to be addressed from many perspectives – including design thinking. Poverty cannot be solved without attention to the interconnections between nutrition, health, infrastructure and education. Grand challenge thinking is equally being tackled and thought about in developed and developing countries, with some of the most interesting experiments on sustainability being driven by the needs of emerging economies.

2.1 Mission-oriented innovation and grand challenges

This type of broad-based innovation policy has been called 'mission-oriented' for its aim to achieve specific objectives (Ergas, 1987; Freeman, 1996). It does not merely facilitate innovation through levelling the playing field with horizontal policies that prescribe no direction. On the contrary, by definition, such policies give explicit technological and sectoral directions to achieve the 'mission'. At the same time, to be successful they must enable bottom-up experimentation and learning (Rodrik, 2004).

Examples of such direction-setting policies abound, including different technology policy initiatives in the United States (Chiang, 1991; Mowery et al., 2010), France (Foray, 2003), the UK (Mowery et al., 2010) and Germany (Cantner and Pyka, 2001). These policies were implemented by mission-oriented agencies and policy programmes: military R&D programmes (Mowery, 2010); the National Institutes of Health (NIH) (Sampat, 2012); grand missions of agricultural innovation (Wright, 2012); and energy (Anadón, 2012). In such cases, it was the organisation that had to make choices on what to fund: tilting the playing field rather than 'levelling it' (Mazzucato and Perez, 2015). Thus the 'picking a winner' problem, which continues to dominate the industrial policy debate, is a static one that creates a false dichotomy: what is crucial is not whether choices must be made, but how 'intelligently' can the picking of 'directions' be performed.

While the literature has focused more on mission-oriented policies in developed countries, there are even more opportunities in developing countries due to the greater 'challenges' they face. Indeed, mission-oriented policies can be a way for the natural resource 'curse' to be approached as natural resources would no longer be seen as belonging to a sector, but rather as being part of a solution to a greater mission. What are the missions that innovation in precious metals can help address? What are the missions that innovation in biotech and agribusiness can address? How can a 'green growth' strategy help to address innovations in traditional sectors that must lower their material content?

A second problem (besides ignoring developing countries) is that the literature on mission-oriented policies has not integrated empirical insights to provide a fully-fledged theory that can replace the orthodox view of direction-less policy. Consequently, 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 policies that contrast those of simply fixing market failures. In a market failure framework, *ex-ante* analysis aims to estimate benefits and costs (including those associated with government failures) while ex-post analysis seeks to verify whether the estimates were correct and the market failure successfully addressed. Instead, a mission-oriented framework requires continuous and dynamic monitoring and evaluation throughout the innovation policy process. In its most general form, the mission-oriented framework differentiates between public policies that target the development of specific technologies in line with state-defined goals ('missions') and those aimed at the institutional development of an innovation system (Ergas, 1987; Cantner and Pyka, 2001). The state must therefore be able to learn from past experiences in mission-oriented innovation policy.

Systemic mission-oriented policies must be based on a sound and clear diagnosis and prognosis (foresight). This not only requires the identification of missing links, failures and bottlenecks – the weaknesses or challenges of a national system of innovation – but also recognition of the system's strengths. Foresight is necessary in order to scrutinise future opportunities and identify how strengths may be used to overcome weaknesses. This diagnosis should be used to devise concrete strategies, new institutions and new linkages in the innovation system (Mazzucato, 2016). It may also be necessary to 'tilt' the playing field in the direction of the mission being pursued rather than 'levelling' it through such means as technologically neutral policies (Mazzucato and Perez, 2015).

In its most general form, the mission-oriented framework differentiates between public policies that target the development of specific technologies in line with state-defined goals ('missions') and those that aim at the institutional development of an innovation system (Ergas, 1987; Cantner and Pyka, 2001). This framework helps us to understand the greater breadth of activities that public spending fosters.

Mission-oriented policies can therefore be defined as systemic public policies that draw on frontier knowledge to attain specific goals or "big science deployed to meet big problems" (Ergas, 1987, p. 53). The archetypical historical mission is NASA's putting a man on the moon. Contemporary missions aim to address broader challenges that require long-term commitment to the development of many technological solutions (Foray et al. 2012) and "a continuing high rate of technical change and a set of institutional changes" (Freeman, 1996, p. 34). The public sector's current active role in tackling renewable energy investments can be seen as a new mission in relation to the green economy (Mazzucato and Penna, 2015b; Mazzucato and Semieniuk, 2017). Other new missions include addressing

such 'grand societal challenges' as the ageing/demographic crisis, inequality, and youth unemployment (European Commission, 2011). In fact, these challenges – which can be environmental, demographic, economic or social – have entered innovation policy agendas as key justifications for action, providing strategic direction for funding policies and innovation efforts.

However, Foray et al. (2012) claimed that modern missions are more complex because there are fewer clear technological challenges and outcomes are less clearly defined. Contemporary missions aim to address broader challenges that require long-term commitment to the development of many technological solutions *and* "a continuing high rate of technical change and a set of institutional changes" (Freeman, 1996, p. 34). One could add that these challenges also require changes at the societal/national systems level. The so-called Maastricht Memorandum (Soete and Arundel, 1993) provides a detailed analysis of the differences between old and new mission-oriented projects (Figure II.4.1):

Figure II.4.1 Characteristics of old and new mission-oriented projects

Old: Defence, nuclear, and aerospace	New: Environmental technologies and societal challenges
Diffusion of the results outside of the core of participants is of minor importance or actively discouraged.	Diffusion of the results is a central goal and is actively encouraged.
The mission is defined in terms of the number of technical achievements, with little regard to their economic feasibility.	The mission is defined in terms of economically feasible technical solutions to particular societal problems.
The goals and the direction of technological development are defined in advance by a small group of experts.	The direction of technical change is influenced by a wide range of actors including government, private firms and consumer groups.
Centralised control within a government administration.	Decentralised control with a large number of agents involved.
Participation is limited to a small group of firms due to the emphasis on a small number of radical technologies.	Emphasis on the development of both radical and incremental innovations in order to permit a large number of firms to participate.
Self-contained projects with little need for complementary policies and scant attention paid to coherence.	Complementary policies vital for success and close attention paid to coherence with other goals.

Science, Research and Innovation performance of the EU 2018

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies

Data: Slightly modified version of table 5 in Soete and Arundel (1993, p. 51).

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_4/part_ii_4_mariana_mazzucato_figure_ii_4_1.xlsx

Although the Memorandum specifically focuses on mission-oriented programmes that tackle environmental challenges, its analysis applies to other contemporary challenges (water and food supply, energy efficiency and security, disease, well-being, demographic change, etc.). This is because all challenges present similar characteristics, particularly the fact that new technological solutions to address them will need to replace incumbent technologies and therefore require long-term commitments from both public and private agents – i.e. the diffusion of solutions to a broad base of users is key.

One of the most pressing contemporary challenges is the need for *inclusion* of vast portions of the population (and of entire regions) in the innovation process and the socio-economic system as a whole, to tackle the issue of inequality[22]. Therefore, missions should, where feasible, be designed in a way that contributes to tackling inequality. Some will do this directly, others indirectly. In some cases, complementary investment in infrastructure and skills will be required if innovation policies are to be effective in addressing inequality. a mission-oriented policy agenda would increase the effectiveness of innovation policy while also having the potential to help rebalance public finances. This is not done by cutting expenditures – as in the prevailing austerity agenda (which often affects the most vulnerable parts of the population) – but by increasing strategic investments which, due to the higher multiplier effect, would increase future revenues.

The six characteristics of contemporary missions identified in Figure II.4.1 – diffusion of technologies, economic feasibility, shared sense of direction, decentralised control by (strategic public) agencies, development of both radical and incremental innovations, and enabling complementary policies – are of pragmatic importance for the promotion and implementation of mission-oriented policies.

A mission-oriented approach highlights the need to make a precise diagnosis of the technological, sectoral or national system of innovation that innovation policy wishes to transform. The alignment of different types of capabilities is key for the success of any mission-oriented policy programme. These can be described, as in Mazzucato and Penna (2016a), as:

- **Missions should be well defined and not overly abstract**. More granular definition of the technological challenge facilitates the establishment of intermediate goals and deliverables, and processes of monitoring and accountability. When governance is too broad, it can become faulty, and there is a risk of it being captured by vested interests.

- **A mission does not comprise a single R&D or innovation project, but a portfolio of such projects**. Because R&D and innovation are highly uncertain, some projects will fail while others will succeed. All concerned should be able to accept failures and to use them as learning experiences. Furthermore, stakeholders should not be punished because of failures derived from efforts made in good faith.

- **Missions should result in a trickle-down effect**, whereby the priorities are translated into concrete policy actions and instruments to be carried out at all levels of the public institutions involved. While these missions should involve a range of public institutions, it is crucial that there is a strategic division of labour amongst them, with well-defined responsibilities for coordination and monitoring.

22 A recent and flourishing body of literature has explored the connections between innovation and systems of innovation and social inclusion. Issues of social development are being studied and targeted in policy action under the heading 'social innovation'. Other recent correlated terms are 'innovation for the bottom of the pyramid' and 'pro-poor innovations'. With respect to sustainability, a minority of contributions seek to expand the concept of sustainability to a social dimension (Cozzens and Kaplinsky, 2009; Soares et al., 2014).

These considerations point to the need to adopt a pragmatic approach to defining missions. Missions chosen should reflect best practice, be feasible, draw on existing public and private resources, be amenable to existing policy instruments, and command broad and continuous political support. They should create a long-term public agenda for innovation policies, address a societal demand or need, and draw on the high potential of the country's science and technology system to develop innovations.

2.2 From directed policy to bottom-up experimentation across sectors

> "*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.*"
>
> Richard Nelson and Sydney Winter, 1982

> "*... shift from total confidence in the existence of a fundamental solution for social and economic problems to a more questioning, pragmatic attitude – from ideological certainty to more open-ended, eclectic, skeptical inquiry.*"
>
> Albert Hirschman, 1987

To a certain extent, providing a straightforward list of missions for a country contradicts the core element in successful mission-oriented programmes. Missions should be determined through a fine-tuned diagnosis of the problem and solution that involves stakeholders and draws on the strengths of the country's system of innovation and considers ways to overcome its weaknesses. Who decides the mission is a key issue that requires more thought. While in the case of the moonshot mission, it was to a large extent a top-down mission led by President Kennedy, the effects of the mission – many of which are in our 'smart' products today – occurred through the bottom-up interaction between different types of organisations that took part in the challenge. Ironically, the modern-day obsession with commercialisation strategies has led to less commercialisation results than those policies that obsessed less with the result and more with the process. In this sense, mission-oriented thinking can learn from Hirschman's emphasis on 'policy as process' and the need to welcome serendipity and uncertainty – what he called the "hiding hand" (Hirschman, 1967).

The nature of bottom-up experimentation is a key industrial strategy requiring both horizontal and vertical policies, working together systemically. Traditionally, industrial strategy often focuses on (vertical) sectoral interventions. Until the end of the 1970s, this consisted of various measures ranging from indicative planning to the outright nationalisation of entire industries (e.g. steel, coal, shipbuilding, aerospace and so on).

Although certain sectors might be more suited to sector-specific strategies, there are good reasons for avoiding a sectoral approach, particularly when it is easily captured by specific interests. Not least, private lobbying interests may prevail in negotiating specific provisions with the government[23], negatively influencing the industrial strategy with short-sighted indirect measures (e.g. tax credits) with the potential to waste public funds and create little or no additionality in terms of new investment. The patent box tax incentive (see note) repre-

23 Buchanan, J. M. (2003). "Public Choice: The Origins and Development of a Research Program", *Champions of Freedom*, vol. 31, pp. 13-22.

sents a typical example of these misconceived policies[24] since there is no reason to lower tax on monopoly profits. In countries where business investment in R&D (BERD) continues to be below the OECD average, sectoral policies risk allowing the private sector to continue to ask for subsidies or support, rather than to fundamentally transform.

The case for building a modern industrial strategy on the identification of challenges, rather than sectors, is compelling and becoming increasingly recognised. a mission-oriented approach uses specific challenges to stimulate innovation across sectors. Through well-defined missions – focused on solving important societal challenges related to climate change and environmental quality, demographic changes, health and well-being, mobility issues, etc. – the government has the opportunity to determine the direction of growth by making strategic investments throughout the innovation chain and creating the potential for greater spillovers across multiple sectors, including lower-tech ones[25].

Interestingly, one of the most well-known missions in the history of capitalism – the Apollo man on the moon mission – sparked innovation across multiple high-tech and low-tech sectors, including textiles.

Germany's *Energiewende* programme for energy transition constitutes a model of how to implement an integrated strategy that addresses several sectors and technologies in the economy and enables bottom-up learning processes. With its missions to fight climate change, phasing-out nuclear power, improving energy security by substituting imported fossil fuel with renewable sources, and increasing energy efficiency, *Energiewende* is providing a direction to technical change and growth across different sectors through targeted transformations in production, distribution and consumption. This has allowed even a traditional sector like steel to use the 'green' direction to renew itself. Indeed, German innovation policy has placed pressure on steel to lower its material content through the use of a 'reuse, recycle and repurpose' strategy[26].

24 Griffith, R., Miller, H. and O'Connel, M. (2010). "Corporate Taxes and Intellectual Property: Simulating the Effect of Patent Boxes", IFS Briefing Note 112, Institute for Fiscal Studies.

25 Foray, D., D. Mowery, and R. R. Nelson (2012). "Public R&D and Social Challenges: What Lessons from Mission R&D Programs?", Research Policy, 41: 1697-1702. Mowery, D. C., R. R. Nelson, and B. R. Martin. (2010). "Technology Policy and Global Warming: Why New Policy Models are Needed (Or Why Putting New Wine in Old Bottles Won't Work)", Research Policy, 39: 1011-1023.

26 BMUB (2016). "German Resource Efficiency Programme II"; available at: http://www.bmub.bund.de/fileadmin/Daten_BMU/Pools/Broschueren/german_resource_efficiency_programme_ii_bf.pdf
Green Alliance (2015), "Circular Economy Scotland"; available at: http://www.green-alliance.org.uk/resources/Circular%20economy%20Scotland.pdf

3. Making and shaping markets not just fixing them

Understanding the dynamic nature of innovation systems and the key role that public agencies have in providing a lead engine, is hard to justify through market failure theory. The idea that the state is at best a fixer of markets has its roots in neoclassical economic theory, which sees competitive markets as bringing about optimal outcomes if left to themselves. This theory justifies government 'intervention' in the economy only if there are explicit *market failures*, which might arise from the presence of positive externalities (e.g. public goods like basic research, which require public-sector spending on science), negative externalities (e.g. pollution, which require public-sector taxation) and incomplete information (where the public sector may provide incubators or loan guarantees)[27]. In addition, the literature on systems of innovation has also highlighted the presence of system failures – for example, the lack of linkages between science and industry – requiring the creation of new institutions enabling those linkages (Lundvall, 1992).

And yet the recent history of capitalism tells a different story – one in which different types of public actors have been responsible for actively shaping and creating markets and systems, not just fixing them; and for creating wealth, not just redistributing it. Indeed, markets themselves are the outcome of interactions between both public and private actors, as well as actors from the third sector and from civil society. In this context, mission-oriented innovation policy is about the creation of new markets, not fixing old ones – and yet this framework has not debunked the market fixing policy framework. Indeed, even the systems of innovation literature (Lundvall, 1992) has not fully divorced itself from a 'fixing' perspective, as the way it is often interpreted is in terms of fixing system failures (e.g. formulating the missing links between science and industry).

3.1 Systems of innovation

> "*The network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies*"
>
> Chris Freeman, 1987

> "*... the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state.*"
>
> Bengt-Ake Lundvall, 1992; p.12

Innovation policy is not just about funding R&D but creating systems which allow new knowledge to be diffused across an economy and create transformative change, including increases in productivity (Freeman, 1987; Lundvall 1992). A *narrow* perspective on systems of innovation can be differentiated from a *broad* perspective (Cassiolato, 2015): the *narrow* perspective is focused on the science and technology subsystem (which includes capacity-building, training and formal education, plus science- and technology-related services) and its relationship with the production and innovation subsystem (where firms mainly operate). The *broad* perspective includes other subsystems and contexts: for example, the subsystems of policy, promotion, representation and financing; demand (market segments); and the (geo)political and socio-economic context.

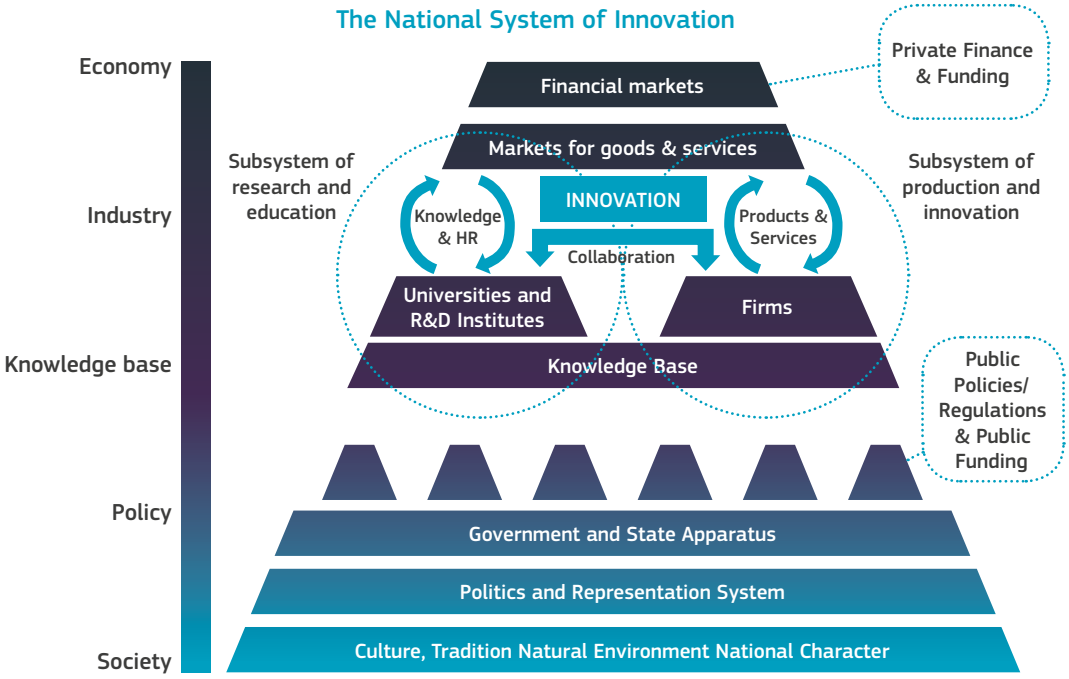
27 Reviews of the impact of positive externalities and incomplete information on innovation financing are provided in Hall (2002), Hall and Lerner (2009) and more recent evidence is reviewed in Kerr and Nanda (2014). Government's role in the face of negative externalities (climate change) is laid out in Jaffe et al., (2005).

Figure II.4.2 depicts a generic national system of innovation. Each level sustains and influences the other. Although the depiction implies a linear hierarchical relationship, in reality, there are mutual causations and flat hierarchies. Thus, there is no uni-directional causality, for example, from policies or science to market strategies and innovation. Nor is there an implication that any layer or subsystem is more important than another.

At the basis of a national innovation system is the socio-economic, political, cultural and environmental context. The next layer up is the government and state apparatus, which is responsible for public policymaking and funding. This is the subsystem of public policies/regulations and public funding. Two other subsystems include production and innovation, which is populated mainly by business firms and their R&D labs, and the research and education subsystem, which includes research and technology institutions (including universities and public R&D labs, as well as other education organisations).

These two subsystems operate on a broad knowledge base and may collaborate with each other. Firms in the innovation and production subsystem engage in market exchanges selling/buying goods and services to/from consumers/suppliers. Universities and research institutes engage in market exchanges for knowledge and human resources. Both subsystems may also draw on financial markets for funding and investments.

Figure II.4.2 Representation of a national system of innovation



Science, Research and Innovation performance of the EU 2018

Source: Authors' construction based on diagram prepared by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT, 2002)

Stat. link:. https://ec.europa.eu/info/sites/info/files/srip/partii/partii_4/part_ii_4_4_mariana_mazzucato_other_charts.ppt

3.2 Nature of actors and of interactions

Systems and eco-systems of innovation (sectoral, regional and national) require dynamic links between the different *actors* and institutions (firms, financial institutions, research/education, public-sector funds, intermediary institutions) as well as horizontal links *within* organisations and institutions (Freeman, 1995). What must also be emphasised, and has not been in the literature on systems of innovation, is the nature of the actual actors and institutions required for innovation-led growth (Mazzucato, 2016a/b).

To stimulate the innovation process by shaping and creating technologies, sectors and markets, dynamic relationships must be developed which create trust between actors. It is essential in this process for the lead public organisation to galvanise the interests of relevant actors and organise itself so that it has the 'intelligence' to think big and formulate bold policies that create a sense of ownership among diverse public, private and academic stakeholders. It is also crucial to be able to implement the policies by coordinating the efforts of this network of stakeholders through the state's convening power, the brokering of trust relationships, and the use of targeted policy instruments.

Because innovation is extremely uncertain, the ability to experiment and explore is key for a successful entrepreneurial state (Hirschman, 1967; Rodrik, 2004; Mazzucato, 2013). Therefore, a crucial element in organising the state for its entrepreneurial role is *absorptive capacity* (Cohen and Levinthal, 1990) or *institutional learning* (Johnson, 1992). Governmental agencies learn through a process of investment, discovery, and experimentation that is part of mission-oriented initiatives.

Other authors have referred to this experimentation and learning process as 'smart specialisation' (Foray et al., 2009). However, smart specialisation is used in connection with a market failure framework, so that it is seen as a discovery process for identifying bottlenecks, failures and missing links (that is, market failures or market gaps). Smart specialisation has not been employed in connection with a systemic perspective on innovation policies.

Key to mission-oriented innovation is exploration of the characteristics of innovation agencies which must be in place so that they can welcome uncertainty and build explorative capacity. Breznitz and Ornston (2013) focus on the role of peripheral agencies, arguing that when they become too central and better funded they lose their flexibility and ability for out-of-the-box thinking. While flexibility is no doubt important, it is also true that some of the most important innovation agencies in Europe and the United States have not been so peripheral, as can be seen by DARPA's continued success in recent years. What seems to be even more important for these organisations is their degree of political independence. Indeed, Italy's public holding company IRI (the Istituto per la Ricostruzione Industriale established in 1933) had its most successful phase before the 1970s when it was public and independent of political interference. It later became problematic when political parties got involved in its decision-making, and even worse, when it became privatised. The key lesson is that it is not about public or private but what kind of public and what kind of private.

It is also central to consider how market-shaping activities can be evaluated outside of a market failure framework to better capture the dynamic spillovers that occur with market shaping and creating policies, a topic we will return to later.

4. A developmental networked entrepreneurial state

In 'The State of Innovation', Block and Keller (2011) build the notion of a developmental network state by studying the host of different public organisations that have led to radical innovations (in various sectors, including pharma and IT), often associated with private sector entrepreneurship. The work is essential for understanding the active role of public institutions in directing innovation policy, not through top-down rigid planning, but through a decentralised interaction between different agencies across the entire innovation chain, which have been at the centre of United States competitiveness. It is precisely this competitiveness that is under threat today due to the United States government's cuts to those very agencies.

In 'The Entrepreneurial State' (Mazzucato, 2013), these lessons are used to reflect on more general principles, building a market-making/-shaping view of policy that goes beyond market fixing. Four key points are emphasised. They focus on the lead investment role of public agencies, taking on extreme risk in the face of uncertainty, which then generates animal spirits and investment in the private sector. These require different types of evaluation techniques to capture the crowding-in process. The key principles include:

- Investment along the entire innovation, including demand-side, policies
- Decentralised nature of public mission-oriented organisations (not top down)
- Risk-taking and investment not only during the downside of the business cycle
- Patient long-term strategic finance
- Considering a more equitable distribution on risk and rewards.

These are briefly reviewed below.

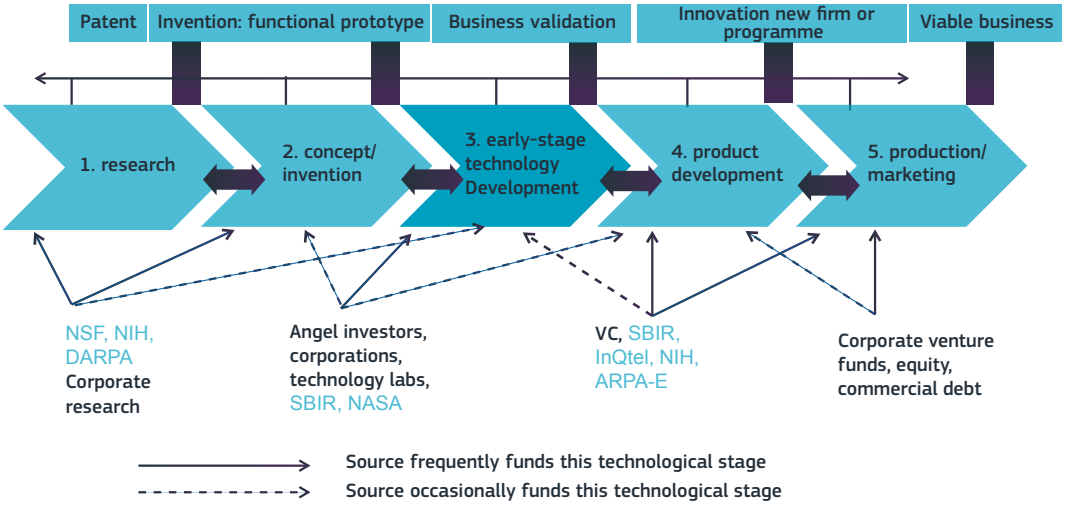
4.1 Investment along the entire innovation chain

Market failure theory justifies intervention when there are clear market failures, such as when there are positive externalities generated from 'public goods' like basic research. Yet while technological revolutions have always required publicly funded science, what is often ignored by the market-failure framework are the complementary public funds that were spent by a network of different institutions further on in the innovation process as well. In other words, the public sector has been crucial for both basic and applied research, and for providing early-stage high-risk finance to innovative companies willing to invest. It was also important for the direct creation of markets through procurement policy (Edler and Georghiou, 2007) and bold demand policies that have allowed new technologies to be diffused (Perez, 2013). Thus, Perez argues that without the policies for suburbanisation, mass production would not have had the effect it did across the economy.

Figure II.4.3 indicates (at the bottom) some of the key public agencies in the United States innovation landscape, including National Institutes of Health (NIH), NASA, DARPA, Small Business Innovation Research Program, National Science Foundation (NSF), etc., that were active across the entire innovation chain. Such organisations have been 'mission driven' – that is, they have directed their actions based on the need to solve big problems and in the process actively created new technological landscapes, rather than just fix existing ones (Foray et al., 2012).

Downstream investments included the use of procurement policy to help create markets for small companies, through the public Small Business Innovation Research (SBIR) scheme, which historically has provided more early-stage high-risk finance to small and medium-sized companies than private venture capital (Keller and Block, 2012), as Figure 4 shows. And guaranteed government loans are regularly used to pump prime companies, such as the US$ 465-million guaranteed government (DoE) loan received by Tesla to produce the 'Tesla S' car.

Figure II.4.3 Mission-oriented finance along the entire innovation chain



Source: adapted from Auerswald/Branscomb, 2003

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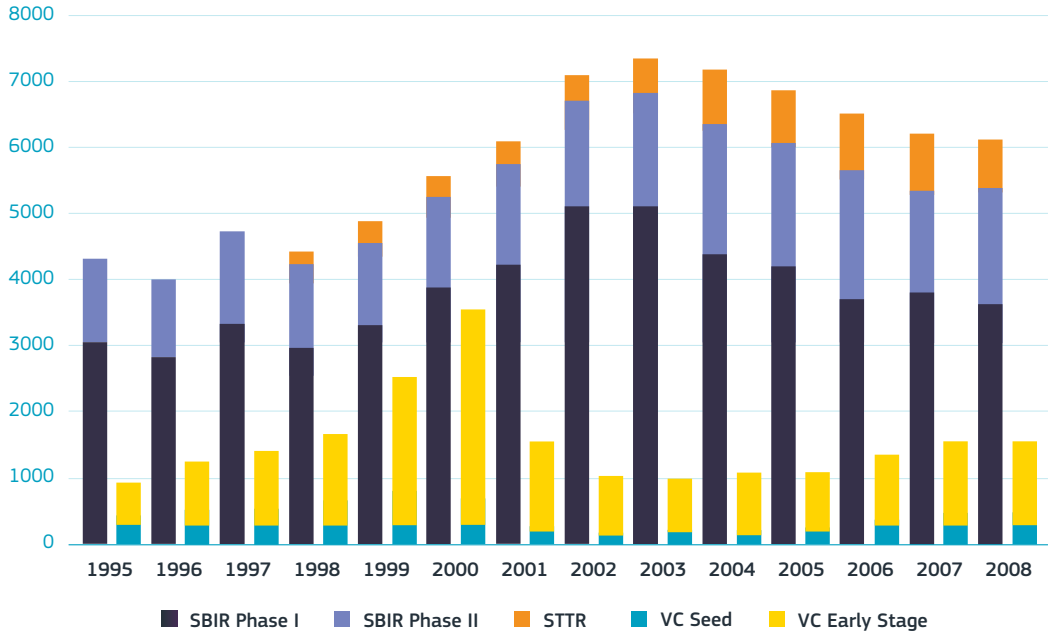
While it is a common perception that private venture capital funds start-ups, evidence shows that most high-growth innovative companies receive their early-stage high-risk finance from public sources, such as Yozma in Israel (Breznitz and Ornston, 2013); venture funds in public banks (Mazzucato and Penna, 2016b); and the SBIR programme funds in the United States (Keller and Block, 2012). While private venture capital is exit driven, seeking returns in three to five years (creating problems outlined in Lazonick and Tulum, 2011), these forms of public finance have been less risk-averse and more patient – thus better suited to the needs of innovation. This lesson does not seem to have been learned in various parts of the developed and developing world which continue to think that attracting venture capital (mainly through tax schemes, such as reductions in capital gains) will foster innovation. In fact, the truth is that venture capital entered industries like the biotech sector in the late 1980s and early 1990s, while the high-risk capital-intensive investments had been done by the United States government in the 1950s and 1960s (Vallas et al., 2011).

In all these cases, government intervention was far from 'neutral', as the market failure framework would suggest. Instead, it deliberately targeted industries and even enterprises with a massive amount of public venture capital assistance. Similarly, in today's renewable energy sector, entrepreneurs like Elon Musk have relied heavily on guaranteed loans from the United States Department of Energy, with the *LA Times* estimating that his three companies (Tesla, Space X and Solar City) together have received over US$5 billion in public support.

Figure II.4.4 Number of SBIR and STTR grants compared to private venture capital, 1995-2008



Source: Block and Keller, 2012

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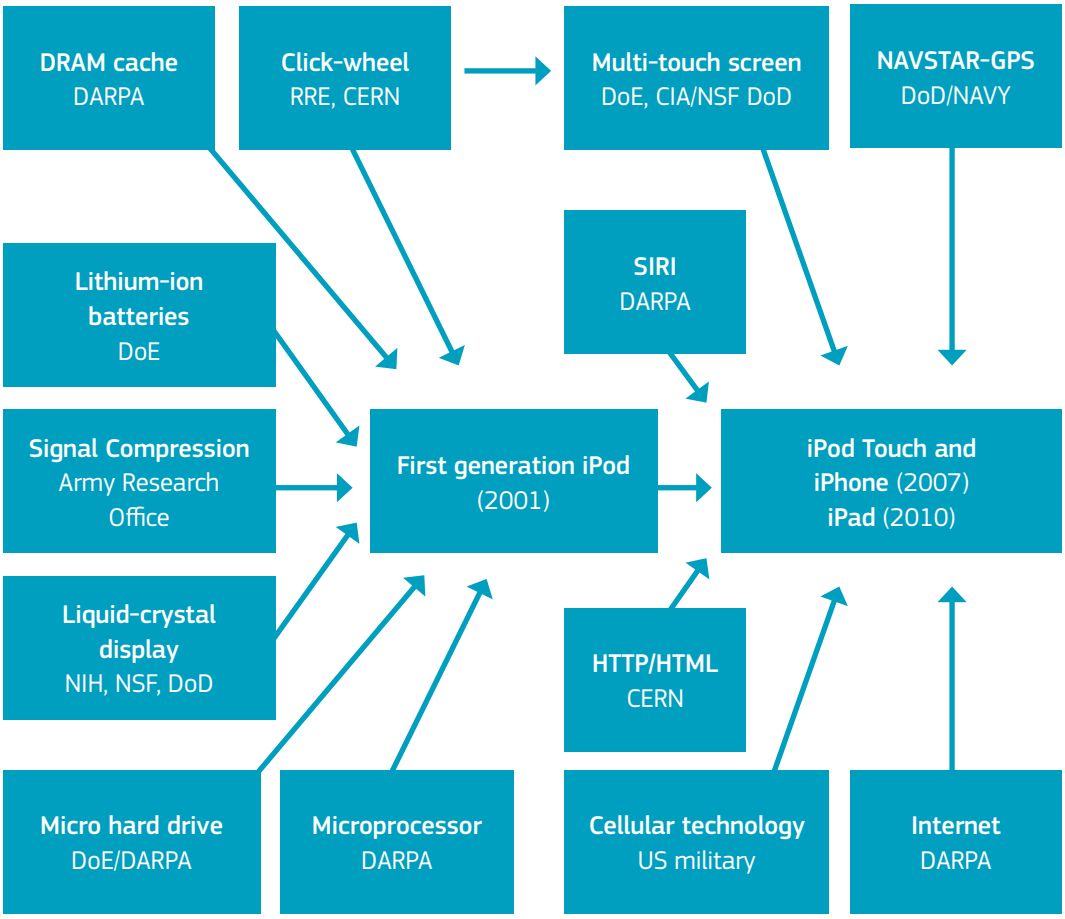
4.2 Decentralised network of *mission-oriented* agencies

Crucial to this public funding was the nature of the organisations themselves, what Block and Keller (2011) have called a *developmental network state*. Better understanding the distribution of the agencies, the positioning across the innovation chain, and the balance between directive and bottom-up interactions is a key area for future study.

As Figure II.4.5 illustrates, in the case of IT, all of the technologies that have made Apple's i-products (iPhone, iPad, etc.) 'smart' were initially funded by different public-sector institutions: the internet by the Defense Activated Research Projects Agency (DARPA); the global positioning system (GPS) by the United States Navy; touchscreen display by the Central Intelligence Agency (CIA); and the voice-activated personal assistant Siri also by DARPA (Mazzucato, 2013a).

Figure II.4.5 Publicly funded technology in 'smart' phones



Source: Mazzucato (2013a), p. 109, Fig. 13.

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But key for our purposes is the fact that most agencies were indeed mission-driven: they did not see their job as fixing markets but as actively creating them. Mission statements can help direct public funds in ways that are more targeted than, for example, simply helping all SMEs. Examples of mission statements are:

- NASA's mission is to "Drive advances in science, technology, aeronautics, and space exploration to enhance knowledge, education, innovation, economic vitality, and stewardship of Earth." (*NASA* 2014 Strategic Plan);
- "*Creating* breakthrough technologies for national security is the mission of the Defense Advanced Research Projects Agency (DARPA)";
- "NIH's mission is to seek fundamental knowledge about the nature and behavior of living systems and the *application* of that knowledge to enhance health, lengthen life, and reduce illness and disability".

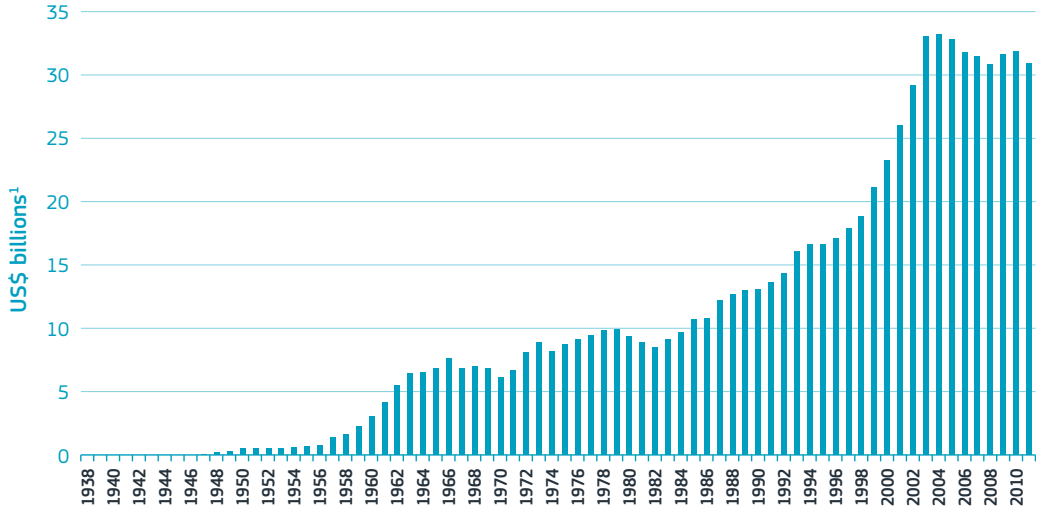
Mission-oriented agencies are potentially better able to attract top talent as it is an 'honour' to work for them. By actively creating new areas of growth, they are also potentially able to 'crowd in' business investment by increasing business expectations about where future growth opportunities might lie (Mazzucato and Penna, 2015).

4.3 Risk-taking across the business cycle

Market failure theory foresees the need also to fix 'coordination failures' such as pro-cyclical spending in the business sector. Indeed, much of Keynesian economics mainly considers the role of the state as essential in recessions (for its counter-cyclical role to prevent depressions), ignoring the fact that public financing of innovation has been just as important in boom periods. Evidence shows that mission-oriented agencies have been critical across the business cycle, and not only to stimulate investment during recessions. Among those agencies mentioned above, the NIH have spent billions on health R&D, stimulating what later became the biotechnology revolution in periods of both boom and bust. In the past, their budgets were increased, even during periods of sustained economic expansion (i.e. by Reagan during the mid-80s and then throughout the 90s). Indeed, the kinds of cuts by the United States government currently being experienced by innovation agencies, including cuts to Arpa-E and NIH, are without precedent, and are very likely to diminish United States competitiveness that has relied on their role as investors and innovators of first resort.

From 1936 to 2016, cumulative R&D expenditure by NIH amounted to more than US$ 900 billion (in 2015 dollars), and annually has been above US$ 30 billion since 2004. Concomitantly, research shows that around 75% of the most innovative drugs on the market today (the so-called 'new molecular' entities with priority rating) owe much of their funding to the NIH (Angell, 2004). Moreover, the share of NIH R&D expenditure in total United States federal outlays in R&D have constantly increased over the past 40 to 50 years. This suggests that the surge in absolute NIH-related R&D expenditure cannot simply be conceived as resulting from a generalised and proportional increase in total R&D expenditure by the government during downturns, or to simply levelling the playing field. Instead, it appears as a deliberate and targeted choice on where to direct public R&D funding.

Figure II.4.6 National Institutes of Health (NIH) – total budgets[1], 1936-2011



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Source: http://officeofbudget.od.nih.gov/approp_hist.html

Note: [1]in 2011 U$ dollars.

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4.4 Patient finance: the importance of public finance

It is precisely due to the short-term nature of private finance that the role of public finance is so important in nurturing the parts of the innovation chain subject to long lead times and high uncertainty. While in some countries this has occurred through public agencies, such as DARPA and NIH (discussed above), in others patient finance has been provided through publicly owned development banks, otherwise known as state investment banks (SIBs).

SIBs have their historical roots in the Bretton Woods' monetary agreements and the reconstruction plans for Europe following World War II. The idea was to create an institution that promoted financial stability through a permanent flow of finance to fund the reconstruction plan and unleash agricultural production potential, thereby preventing the deleterious effects that speculative private finance could have on post-WWII economic recovery (World Bank, 2013). Following this rationale, the International Bank for Reconstruction and Development (IBRD) was created, providing its first loan to France in 1947[28]. Other national development banks were founded around that time, such as KfW in Germany (1948) (Schroeder et al., 2011), with the aim of channelling international and national funds to the promotion of long-term growth, infrastructure and modern industry. While in industrialised countries

28 World Bank, History [Online]; available at: http://go.worldbank.org/65Y36GNQB0 [accessed 12/15/2015].
M. Schröder et al., op. cit.

these institutions focused on niche areas (such as aiding specific sectors), in developing countries SIBs such as the Brazilian BNDES initially promoted a catching-up agenda, with heavy investments in infrastructure (Torres Filho and Costa, 2012).

In subsequent decades, SIBs diversified their operations and focus. In the mid-1950s, KfW assumed the responsibility of providing finance for environmental protection and small and medium-sized enterprises (SMEs), roles that were intensified in the 1970s when it also began to target energy efficiency and innovation[29]. Other development banks followed suit: BNDES, for instance, created new credit lines for SMEs in the 1980s, and in the following decade began to experiment with financing programmes targeted at high-tech firms and innovation development[30]. By the 2000s, the China Development Bank (CDB) was one of the most active SIBs, investing in regional economic development and industrial catching-up; supporting and nurturing new ventures and innovation development; and, later in the decade, targeting finance to projects aimed at 'green growth' (Sanderson and Forsythe, 2013). Following the outbreak of the global financial crisis in 2007, SIBs across the world significantly promoted counter-cyclical credit, increasing their loan portfolio by 36% on average between 2007 and 2009, with some increasing their loans by more than 100% (Luna and Vincente, 2012).

While the traditional functions of state investment banks were in infrastructure investment, and counter-cyclical lending during the recession when private banks restricted credit (thus playing a classic Keynesian role), over time they have become more active as key players in the innovation system. They have provided the patient capital for innovative firms, and also focused on modern societal challenges with technological 'missions'. For example, SIBs have notably filled the vacuum left behind by private commercial banks since the outbreak of the crisis, more than trebling their investments in clean energy projects between 2007 and 2012[31]. A recent report by Bloomberg New Energy Finance finds that in 2013 state investment banks were the largest funders of the deployment and diffusion phase of renewable energy, outpacing investment from the private sector (Louw, 2011). The four most active banks are (in order) the Chinese Development Bank, the German KfW, the European Investment Bank (EIB), and the Brazilian BNDES. Examples of 'mission-oriented' investments include the European Investment Bank's EUR 14.7 billion commitment to sustainable city projects in Europe (Griffith Jones and Tyson, 2012), the efforts of KfW to support Germany's *Energiewende* policies through the greening and modernisation of German industries and infrastructures, China Development Bank's investments in renewable energies, and the technology fund put in place by BNDES to channel resources toward selected technologies in Brazil (FUNTEC)[32]. Figure II.4.7, for example, illustrates the way in which KfW has not only played a classical Keynesian counter-cyclical role, but has also directed that funding towards 'climate financing'.

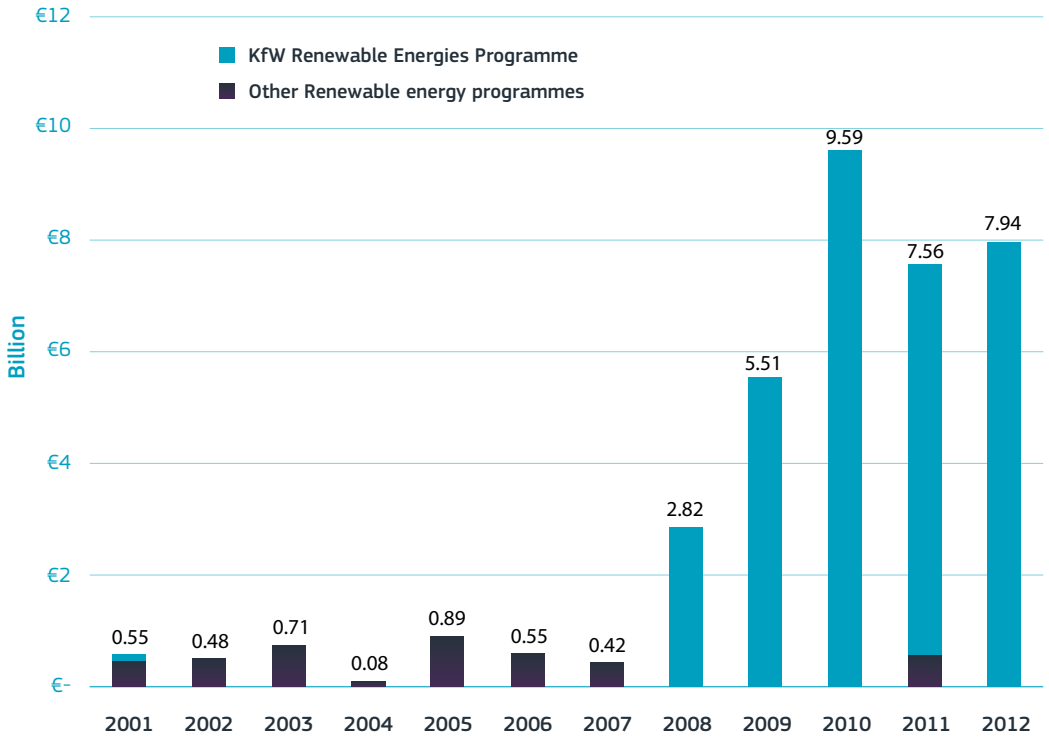
29 KfW, 'Annual Report 2008', Frankfurt am Main, 2009, KfW Group.

30 C.E. Branco, 'Apoio às Pequenas e Médias Empresas de Base Tecnológica: a Experiência do Contec', Revista do BNDES, Vol. 1, 1994, pp. 129-142; F.L.D. Sousa (ed.), 'Bndes 60 Anos: Perspectivas Setoriais', 2012, Rio de Janeiro: BNDES.

31 L.S. Fried, S. Shukla and S. Sawyer (eds.), 'Global Wind Report: Annual Market Update 2011', Global Wind Energy Council, March 2012.

32 BNDES 2012, 'Apoio À Inovação', 2012, Rio de Janeiro: BNDES.

Figure II.4.7 KfW Funding for industrial environmental and climate protection projects in Germany, 2001-2012



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4.6 Risks and rewards

More explicit consideration of these roles enables us to reflect on the degree to which the division of labour in risk-taking is or is not matched by a division of rewards, which would be expected if there is a *risk-return* relationship. It also helps us to better understand whether the eco-system is creating the right incentives. Is it the case that because some actors are putting in a lot, other actors have been given fewer incentives to do their share?

Innovation is highly uncertain: for every success (e.g. the internet) there are many failures. High failure rates are just as common upstream (in R&D projects) as downstream in the public financing of firms. It is thus essential to better understand how portfolios are managed in mission-oriented agencies – such as Yozma in Israel, Sitra in Finland or SBIR in the United States. This requires a lead investor understanding of public funds that goes beyond the need to correct for asymmetric information. It is not a matter of a lack of information, but rather the willingness to engage in big thinking and its underlying uncertainty.

Having a vision about the direction in which to drive an economy requires direct and indirect investment in particular areas, not just creating the horizontal (framework) conditions for change. Crucial choices must be made, the fruits of which will create some winners but many losers. For example, the United States Department of Energy recently provided guaranteed loans to two green-tech companies: Solyndra (US$ 500 million) and Tesla Motors (US$ 465 million). While the latter is often glorified as a success story, the former failed miserably and became the latest example in the media of government being inefficient and unable to *pick winners* (Wood, 2012). However, any venture capitalist will admit that for every winning investment (such as Tesla) there are many losses (such as Solyndra). In making downstream investments, therefore, governments can learn from venture capitalists' portfolio strategies, structuring investments across a risk space so that lower risk investments can help to cover the higher risk ones. In other words, if the public sector is expected to compensate for the lack of private venture capital (VC) money going to early-stage innovation, it should at least be able to benefit from the wins, as private VC does. Otherwise, the funding for such investments cannot be secured. As argued in Mazzucato and Wray (2015), even if money could be secured for public investments endogenously (through money creation), it is desirable to allow the state to reap some of the rewards from its investments for several other reasons. Matching this type of spending with the corresponding return would provide a measure of efficiency, holding policymakers accountable; government net spending has limits dictated by the real resource capacity of the economy; and voters will be more willing to accept the (inevitable) failures if they see that those are compensated by important successes.

The public sector can use a number of return-generating mechanisms for its investments, including retaining equity or royalties, retaining a golden share of the IPR, using income-contingent loans, or capping the prices (which the taxpayer pays) of those products that emanate, as drugs do, from public funds (Mazzucato 2013). However, before exploring the details of each mechanism, it is crucial for the policy framework to even allow the question to be asked. In a market-shaping framework, does government have the right 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?

4.7 Learning the right lessons from 'The Entrepreneurial State'

Weiss (2014) cautions on the role of United States public agencies in fostering innovation. She highlights the strong military and security interests that have shaped United States innovation policy, and the way that corporate interests have taken advantage of these.

It is right to be cautious. And it is precisely a wide debate about what it means to have mission-oriented thinking that can allow active public policy in innovation to be redirected towards societal needs (and the 'wicked problems' that connect health, sustainability, nutrition, education, and poverty), and not only military and security needs. By creating a more symbiotic relationship between the public and private sectors – focused on 'additionality' targets – the possibilities particular sectors have to capture innovation policy is reduced, as is the possibility that particular companies lobby for policies (including tax policies) which increase profits but do not help to generate public value. Understanding how the definition of missions can be opened up to a wider group of stakeholders, including movements in civil society, is a key area of interest. Indeed, to a large extent, it was the green movement in Germany (including but not restricted to the Green Party) that led to a slow cumulative interest in society about tackling green missions, such as that represented in the *Energiewende* agenda.

Understanding new, more democratic processes through which missions are defined and targeted is tied to rethinking the notion of public value. Indeed, part of building a market-shaping and creating framework that can guide mission-oriented thinking, that goes beyond the market-failure framework, involves rethinking public value beyond the notion of the 'public good'. Too often, the public good concept has been used to limit and constrain the activities of public actors, immediately accusing ambitious policies of 'crowding out' private activity (Mazzucato and O'Donovan, 2016). But similarly, achieving public value cannot be the work of the public sector alone. Hence, opening up this process to include a wider set of stakeholders who can be involved in the definition of missions as well as the serendipitous process of how to achieve them, will be an exciting new area of analysis linked to 21st century innovation policy targeting grand challenges.

> "*Public values are those providing normative consensus about (1) the rights, benefits, and prerogatives to which citizens should (and should not) be entitled; (2) the obligations of citizens to society, the state, and one another; (3) and the principles on which governments and policies should be based*" (Barry Bozeman, 2007, 13).

5. Final thoughts: implementing mission oriented policies

The examples of history and future potential have led to growing interest in mission-oriented policy approaches from around the world. But questions remain about how to apply the lessons of history to the challenges of today.

When policymakers acted in this way in the past, they had to work outside established policy frameworks. What is needed is a policy framework they can work within: a new framework that can be used to justify, guide and evaluate mission-oriented innovation policies.

The challenge is to develop this new framework, along with the analytical tools, related policy apparatus, and new organisational capabilities to enable policy-makers to apply it in practice – in relation to different types of challenges and in different spatial or other contexts. To conclude this scoping paper, some general principles are listed below.

5.1 Linking innovation policy to the systemic characteristics of innovation

Innovation policy must build on the key characteristics of how innovation comes about: it is uncertain, cumulative, and collective (Lazonick and Mazzucato, 2012). Uncertainty means that agents concerned with innovation cannot calculate in advance the odds of success or failure – that is, results are unknown – and therefore in order to succeed they will also have to accept occasional failures and detours from the planned routes. **Cumulative** means that agents need to be patient and act strategically to accumulate competences and capabilities (learn) with a view to the long term. **Collective** means that all agents need to work together and thus bear certain degrees of risk; therefore, they are also entitled to share the rewards.

Policies based on a mission-oriented perspective are **systemic**, employing but going beyond science-push instruments and horizontal instruments. Mission-oriented policies employ an array of financial and non-financial instruments to promote the accomplishment of a mission across many different sectors, setting concrete **directions** for the economy, and deploying the necessary network of relevant public and private agents.

A *broad perspective* on the national system of innovation identifies **four subsystems**: (i) public policy and public funding; (ii) research and education; (ii) production and innovation; and (iv) private finance and funding. While all subsystems are in theory of strategic importance, the public policy and funding subsystem has traditionally led the process of socio-economic development and technical change.

To stimulate the innovation process by shaping and creating technologies, sectors and markets, **new relationships** must be developed and more trust created. The state must galvanise the interests of relevant actors and organise itself so that it has the 'intelligence' to think big and formulate bold policies that also create a sense of ownership among diverse public, private and academic stakeholders. It is also crucial to be able to implement the policies by coordinating the efforts of this stakeholder network through the state's convening power, brokering trust relationships, and using targeted policy instruments.

Systemic mission-oriented policies must be based on a sound and clear **diagnosis** and **prognosis** (foresight). This requires not only the identification of missing links, failures and bottlenecks – the weaknesses or challenges of a national system of innovation – but also identification of the system's strengths. Foresight is necessary to scrutinise future oppor-

tunities and to identify how strengths may be used to overcome weaknesses. This diagnosis should be used in devising concrete strategies, new institutions and new linkages in the innovation system. It may also be necessary to 'tilt' the playing field in the direction of the mission being pursued rather than 'levelling' it through such means as technologically neutral policies.

To fulfill a mission, a country requires an **entrepreneurial state**. This concept encapsulates the risk-taking role the state has played in the few countries that have managed to achieve innovation-led growth. It is through mission-oriented policy initiatives and investments across the entire innovation process – from basic research to early-stage seed financing of companies – that the state is able to have a greater impact on economic development.

The state must be able to **learn from experience** in mission-oriented innovation policy. In a market-failure framework, *ex-ante* analysis aims to estimate benefits and costs (including those associated with government failures) while *ex-post* analysis seeks to verify whether the estimates were correct and the market failure successfully addressed. a mission-oriented framework requires continuous and dynamic monitoring and evaluation throughout the innovation policy process.

Definitions of missions will increasingly require more involvement by stakeholders, both to gain democratic legitimacy (in an era in which it is threatened) and also to achieve a broader notion of public value than that which has been used.

5.2 Different types of capacity building

As highlighted in Mazzucato and Penna (2016a), different types of capacity building are central to mission-oriented policies:

Scientific-technological capacity: an appropriate scientific and technological knowledge base in the education and research subsystem;

Demand capacity: latent or effective (public or private) market demand, in terms of both purchasing power and need;

Productive capacity: an appropriate business base (for example, existing firms or entrepreneurs willing to take risks to establish an innovative firm) in the production and innovation subsystem;

State capacity: appropriate knowledge inside the public organisations formulating and executing the policies about the problem and solution being targeted and/or knowledge about 'who knows what and how';

Policy capacity: appropriate supply-side and demand-side policy instruments (strategically deployed), supported by complementary policies;

Foresight capacity: a fine-tuned diagnosis of the problem and solution, including an analysis of the current situation and future prospects for targeted technologies and sectors, formulated in terms of a well-defined mission and vision.

Successful mission-oriented policy experiments require all six factors in place whereas, in less successful areas, they require a more dynamic framing of key questions: less about picking or not picking, and more about the institutional and organisational capacity of forming broadly defined directions, through strategic deliberation; less about static cost-benefit metrics which so often result in accusations of 'crowding out' and more about dynamic assessment criteria that can nurture and evaluate market-shaping processes (so that ambitions are not immediately accused of crowding out). In this respect, four key

questions can guide the process of developing the new framework to justify, guide and evaluate mission-oriented innovation policies (discussion of the questions in Mazzucato, 2016a):

Routes and directions: how to use policy to actively set a change in direction; how to foster more dynamic (bottom-up) debates about possible directions to ensure enduring democratic legitimacy; and how to choose and define particular missions concretely, but with sufficient breadth to motivate action across different sectors of the economy.

Organisations: how to build decentralised networks of explorative public organisations which can learn by doing and welcome trial and error, with the confidence and capability to lead and form dynamic partnerships with private and third-sector partners; how to manage and evaluate progress, learning and adaptation; and how to use a portfolio approach to balance inevitable failure with success.

Assessment: how to evaluate the dynamic impact of public-sector market-creating investments, going beyond the static ideas embodied in cost/benefit analysis and ideas of 'crowding in' and 'crowding out' based on a richer conception of public-value creation; and how to develop new indicators and assessment tools to aid decision-making.

Risks and rewards: how to form new deals between public and private sectors so that rewards as well as risks are shared.

These questions provide a starting point for the new categories of thought required, with many more questions following in relation to application in particular contexts.

Figure II.4.8 below can be used to reflect on the practical steps that might be useful for mission-oriented organisations (with arrows being interpreted not linearly but in terms of key steps):

Figure II.4.8 Practical steps to build mission-oriented thinking in innovation policy

Mission selection	How to select missions that have enduring and democratic legitimacy
Co-production	How to engage public, private and third sector actors in mission selection, implementation, learning and evaluation processes
Mission definition	How to define missions concretely but with sufficient breadth to motivate action across multiple sectors of the economy, enabling new types of interactions between public, private and third sectors, and over different time horizons
Dynamic capacities	How to develop new competencies and capabilities for dynamic change: ability to envision new futures and to acommodate risk-taking, experimentation and underlying uncertainty of the discovery process
Decision tools	How to develop new indicators and assessment tools to aid decision-making and evaluate impact, beyond the static cost/benefit framework
Managing future	How to manage inevitable failure as well as success by taking a portfolio approach
Sharing rewards	How to ensure rewards as well as risks are shared so that so that the growth generated is inclusive as well as smart

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