



Contents lists available at ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

Socializing the risks and rewards of public investments: Economic, policy, and legal issues[☆]



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ARTICLE INFO

JEL classification:

O31 innovation and invention: processes and incentives

O38 government policy

K40 General: legal procedure

The legal system and illegal behavior

Keywords:

Innovation policy

Risk capital

Entrepreneurial state

Portfolio

public–private partnerships

Legal institutions

ABSTRACT

We develop a framework for analyzing the role of public agencies in making high-risk investments along the innovation chain and ask how both the risks of innovation *and the rewards* can be shared between public and private actors. We build on a new approach to innovation policy, which we call *market co-creating and shaping*, in which the state is not only fixing markets but actively co-creating them. We also look at the legal institutions that determine (and are determined by) the relationship between public and private actors. Policy measures to institutionalize rewards in a way that promote more equitable public–private partnerships can be understood as attempts to mediate asymmetric power relations, tensions and conflicting views among multiple stakeholders, as well as building a shared notion of the value and legitimacy of the role of the state. We conclude by outlining analytical and policy implications and identifying avenues for future research.

1. Introduction

The last fifty years have witnessed the emergence of several disruptive technological innovations – from ICT to biotech and, more recently, renewable energy – that have involved profound institutional changes and brought unprecedented levels of value creation. This has required both public and private investments across the entire innovation chain. However, while the private risk-taking has been recognized and elaborated through attention to ‘entrepreneurship’ (Acs and Audretsch, 2005) and wealth creation, public investments have remained framed in the context of fixing market failures (Samuelson, 1997). The idea that innovation is led by private entrepreneurs who benefit at most from horizontal market fixing funding (infrastructure, skills, grants) has prevailed in the theory and rhetoric behind innovation policy.¹

The market failure view of government funding has a particular understanding of returns. While private enterprises deserve the ‘profit’ created, public organizations can gain by focusing on spillovers that emerge from wealth creation. That is, from a societal standpoint, as long as adequate framework conditions are in place, the advantages of optimal

levels of public spending in R&D confined to fixing markets, will occur through the creation of ‘social returns’ such as knowledge spillovers and public goods, better quality and cheaper goods and services (‘consumer surplus’), and job creation, ultimately resulting in economic growth and positive fiscal impact.

Yet what is increasingly evident from the literature on the developmental state (Block and Keller, 2011) and the entrepreneurial state (Mazzucato, 2013) is that the state does much more than fix market failures. It has taken on some of the highest risk investments along the entire innovation chain, not limited to upstream R&D but also, for example, the provision of downstream patient long term finance in the forms of grants and loans to companies. Indeed, the various public policy instruments that led to Silicon Valley, are hardly just market fixing: they have actively created markets. This begs the question whether the assumptions of how risks and rewards are shared in mainstream literature needs a revision to better take into account the more active level of risk-taking played by the state. To be sure, the point here is not to argue for a more active role of the state but to ask whether its current risk-taking role is taken into account when assuming the distribution of the rewards.

[☆] This article was originally published in *Research Policy: X*. *Research Policy: X* is now discontinued and the article is republished here for the reader's convenience. For citation purposes, please use the publication details of this article: *Research Policy*, 49S.

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¹ We use ‘innovation policy’ broadly to mean policies that have a significant effect on innovation (Edler and Fagerberg, 2017). Innovation is defined in Schumpeterian terms as new combinations of existing knowledge, capabilities and resources brought into the market, thus distinguishing them from mere inventions (Schumpeter, 1934). Using this definition, innovation policy in some respects overlaps with what may be called ‘technology policy’ or ‘industrial policy’. However, we consider that industrial policy is broader in scope (see, for instance, Andreoni and Chang (2019)).

<https://doi.org/10.1016/j.repolx.2020.100008>

Received 9 June 2019; Received in revised form 28 March 2020; Accepted 6 May 2020

Available online 15 May 2020

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Mazzucato (2013) made a step to fill this gap by illustrating the immense public investment that have provided the foundation for the success of companies like Google and Apple (e.g. all the technologies like the Internet, GPS, and Siri in smart products are funded by the public sector). She argued that the state could become wiser in its distribution of rewards so that both risks and rewards are socialized. Instruments proposed included equity, royalties and conditions of reinvestment. Lazonic and Mazzucato (2013) built on this work by offering a comprehensive framework named the 'risk-reward nexus' to investigate the relationship between how risks are taken in innovation and how the rewards are distributed. Their main argument is that the collective, cumulative and inherently uncertain nature of innovation processes enables the dissociation between the risks taken and rewards realized by different types of economic actors – workers, citizens (represented by the state) and shareholders. A particular focus of their analysis was on the way that the pharmaceutical companies have been able to freeride on the back of high-risk funding from organizations like the National Institutes of Health—without the public contribution being taken into account when (1) pricing drugs, (2) governing patents, and (3) distributing returns to shareholders (see Mazzucato et al., 2018). The authors focused on the strategies that allow financial actors to position themselves along the innovation chain and extract more value than their contributions could have generated on their own, at the expense of the other actors.

This paper complements these studies by looking at the relationship between the role of the state as an investor and the extent to which public funding agencies attempt to reap a share of financial rewards realized in partnerships with business. This analysis builds on a new framework – market co-creating and shaping – in which the state is a leading actor and entrepreneur working in close collaboration with the private sector and is therefore endogenous to economic processes (Mazzucato, 2016, 2013). We adopt a perspective that highlights the constitutive role of the state, in the institutional shaping of market relations, society and the state itself, which some scholars have referred to as 'legal Institutionalism' (Hodgson, 2015; Deakin et al., 2017). This approach makes it possible to go beyond the notion of legal rules and contracts as background incentives for profit-maximizing agents, and to assess their quality in terms of the potential for shifting the nature, goals or meanings of economic activity and organization to deliver increased wellbeing (Stryker, 2003). Bringing these economic and legal angles together allows us to better analyze and comprehend the dynamics of public-private partnerships concerning risk-and-reward distributions.

Our aims are two-fold. One is to provide an analytical foundation that enables to reframe innovation policy efforts related to the risk-reward nexus. By conceptualizing the institutionalization of reward structures as a social, legal and political process – rather than an optimal end-point – the new framework should help researchers and decision-makers identify some of the relevant dilemmas. The second aim is to advance knowledge that can guide better policy tools and practices towards socializing the risks and rewards of public investments, to promote inclusive, innovation-led growth. Hence, this framework operates at the level of a mid-range theory akin to policy guidance, as opposed to abstract or general theory (George and Bennett, 2005).

In Section 2 we review the market failure approach to innovation policy and its main shortcomings, with reference to some alternative frameworks. In Section 3 we introduce three bodies of literature that lay the foundations for a new approach: (i) the developmental state, (ii) legal institutionalism and (iii) the entrepreneurial state. In Section 4 we ask how the state can capture a share of the rewards that better reflects its role as a risk-taker. We conclude the paper by outlining analytical and policy implications, and areas for future research.

2. The market failure approach to innovation policy and its main shortcomings

Within the neoclassical economic framework, innovation policy is viewed as fit for correcting market failures, stemming from the notion that

'free' market interactions play a prominent role in the economy. The production function is the conceptual model of value creation within firms, wherein the use of labor and capital inputs produces new products and services. As the primary organizer of production and owner of the capital assets involved, the private sector is the leading entrepreneur. Government's role is to guarantee the necessary conditions for markets to operate and to intervene in the economy to correct 'market failures'.

Regarding innovation, market failures involve under- or over-investment by business. A classic example refers to the 'public good' nature of basic research, which offers insufficient incentives for firms to invest given the high spillover effects, making it difficult to appropriate returns (Nelson, 1959; Arrow, 1962). There is also asymmetric or incomplete information in the financial markets, which increases the cost for firms – especially SMEs – to finance R&D (Hall and Lerner, 2010). Eventually, investments in certain areas exceed the desirable levels, for instance when negative externalities such as those created by patent races, pollution or traffic congestion take place (Stiglitz, 2000). The government's direct financing has a limited role in fixing those problems and should focus on scientific research and SMEs. As public funding moves downstream, it receives more criticism, because, in theory, spillover effects are not as significant as those that occur upstream, and companies are in a better position to capture returns.

The expectation of achieving high social benefit through public funding is vital for legitimizing innovation policy. And again, despite the skepticism about the state's ability to do so effectively, the fact remains that many public-private partnerships lead to commercial success, yielding high financial rewards that the government may not be able to appropriate. The assumption is that government's role in fixing markets naturally generates a return through welfare increases and economic growth. As a result, the benefits to society – the 'social returns' – are new and better goods at reduced prices for consumers ('consumer surplus'), 'public good' provision, knowledge spillovers and new jobs. Also, these benefits reflect a positive fiscal position. Supposing that supported companies and individuals pay their due taxes, increased economic activity contributes to increased tax collection (one of the primary mechanisms through which the state recoups a financial gain). While imperfections may block or reduce the optimal social rate of return, these are just imperfections for government to fix. In short, because this approach is based upon the perception that public funding is a passive tool for boosting private entrepreneurship, governments tend to pay insufficient attention to how to appropriate the rewards of public investment.

Implicit here is also a limited view on the role of the state regarding the rules underpinning market interactions and the underlying written or informal contracts on which actors must agree. These rules and contracts are crucial, however, as they ultimately define reward distributions between public and private actors. Assuming that economic exchanges only happen among private owners, the state appears as an external entity responsible for the rule of law. It helps the market system operate at its best by ensuring robust and stable institutions through well-defined property rights and rigorous contract enforcement (Posner, 2014).

Accepting that only one best set of rules maximizes economic welfare (Coase, 1960), economic analyses of contractual relationships have mostly taken the underlying rules as given. Consequently, according to the literature on new institutional economics, the role of government, operating through courts, is at best limited to seeking efficient or aligned incentive structures that enable shareholder maximization and transaction cost mitigation (Jensen and Meckling, 1976). At worst, the state is almost irrelevant and ineffective in filling gaps, correcting contractual errors or settling any arising disputes (Williamson, 1988). Even when the rules of the game are admittedly endogenous, the political, economic and social contexts reduce maneuvering room (North, 1990). Therefore, any policy guidance derived from this approach will deal with removing legal barriers and strengthening the incentives for profit-maximizing entrepreneurs.

The market failure framework for innovation policy has, however, attracted significant criticism. The ‘systems of innovation’ literature qualified that while substantial innovations happen within firms, they depend on a complex network of actors, institutions and interactions that influence the rate and pattern of knowledge creation and diffusion across the economy (Lundvall, 1992; Freeman, 1995). Neo-Schumpeterian and evolutionary theory has highlighted that while neoclassical economics examines existing landscapes (markets, sectors or technologies) and existing trajectories (whether firms are investing too little or too much in a given area), it overlooks the dynamic and cumulative process through which new landscapes and trajectories come about (Dosi, 1982). It also neglects the range of actors that contribute to changing them – in particular the related problems of alignment and coordination –, and this is an area that has received increased attention in the transformative innovation policy literature (Schot and Steinmueller, 2018).

A significant shortcoming of the market failure approach, in the context of the present article, is the passive role attributed to public finance (Perez, 2003; Mazzucato, 2013). This has meant that the approach does not include the possibility of having an array of mechanisms, beyond taxation, that public agencies may deploy in order to recoup a share of financial rewards of investments. Examples include royalties on intellectual property rights (IPR) or sales and equity stakes on supported firms. A related problem is the neglect of the state’s influence on the rules and contracts that underpin public–private partnerships, through legislators, regulators, courts (Pistor, 2009; Hodgson, 2015; Deakin et al., 2017) and funding agencies themselves (Mowery, 2009; Mazzucato, 2013; Hockett and Omarova, 2016). These shortcomings, and that the alternative frameworks reviewed in this section do not explicitly discuss the distribution of risks and rewards,² suggest the need for a new conceptual framework for innovation policy that extends the justification for public funding. Such a framework must consider the risks taken by state actors, the legal grounds and procedures for them, and the legal instruments adopted for capturing rewards.

3. Towards a new framework: market co-creating and shaping

Three bodies of literature lay the foundations for a new approach for policy. These are on (i) the developmental state, (ii) legal institutionalism and (iii) the entrepreneurial state. The first draws on Karl Polanyi’s insights on the nature of markets as socially embedded, stressing the active and endogenous role of the state in economic transformations (Polanyi, 1944). The second disentangles the collective processes through which legal arrangements frame, influence, and sustain the organization of the economy and the state. The third sheds light on the risk-taking role of public actors as a driver of the rate and direction of innovation.

Bridging these complementary and sometimes overlapping bodies of literature allows for a richer understanding of the complexities, complementarities, tensions and power relations underlying the dynamics of public–private interactions in innovation. On this basis, the market itself becomes an outcome to which the state, operating through multiple actors, makes a vital contribution (Mazzucato, 2016).

3.1. The developmental state

In his description of the emergence of capitalism, Polanyi (1944) emphasizes that policies are not ‘interventions’, but that markets are embedded in social and political institutions, and largely influenced by them (Polanyi, 1944; Evans, 1995). Studies on the developmental state have conceptualized and documented such an intrinsic and active state leading profound transformations such as those involved in the development of emerging East-Asian economies (see Amsden, 2001; Wade, 1990; Woo-Cumings, 1999; Chang (1999)). This ‘visible hand’ acts

² Different framings of innovation policy have, nonetheless, different implications for the distribution of risks and rewards between actors in the public and private sector.

as a capital provider and coordinator of industrialization and technical change processes.

This literature has expanded into the concept of a developmental network state, exposing the often hidden activity of public agencies that also governs change in advanced economies (Ó Riain, 2004; Block, 2008; Block and Keller, 2011). While past industrialization experiences targeted imitation and adaptation of existing technologies, the contemporary model puts innovation – R&D and commercialization – at the center of competitive strategies. High-tech booms in countries like Israel, Taiwan, Ireland and the United States exemplify policies encouraging activities that were not being done at all, working as devices to revitalize the economy.

Another distinctive feature refers to the decentralized, ‘networked’ and flexible structures on which government relies (Ó Riain, 2004), rather than the top-down, centralized organization exemplified by the MITI, in Japan. Various types of public agencies operate by engaging in direct and close partnerships with businesses (Block and Keller, 2011). Public officials who have a problem-solving focus perform a range of activities that do not fit under the market failure framework: targeting resources in promising areas; opening windows that enable support for other innovations; brokerage; and facilitation (such as providing infrastructure and standards). Such proactive stances can enable the creation of new networks of collaboration or stimulate those that already exist. Hence, they are key to the accumulation and diffusion of knowledge that drives technological change (Block, 2008, pp. 172–179).

3.2. Legal institutionalism

Drawing on various traditions,³ emerging studies serve to restore the view on legal institutions – including the state – as playing a central, constitutive role in capitalist societies and as a source of power (Hodgson, 2015). The term ‘legal institutionalism’ has been used to refer to this approach, which is still dispersed in the literature and does not yet incorporate a fully structured theory (Deakin et al., 2017), but it does offer useful insights on the interrelations between legal and economic processes, policy and social change, otherwise obscured under the notion of ‘embeddedness.’

From this perspective, legal arrangements that structure markets and other institutions are outcomes rather than natural circumstances. The interactions of legislators, courts and policymakers with a broader group of actors, including firms and civil society, are indispensable for sustaining legal rights and obligations. This is partly because the effectiveness of those arrangements also lies in shared norms and values informing perceptions regarding their reasonableness, fairness, and compliance with established rules (Commons, 1959). Enabling participation is important for legitimation in democratic environments. Legal institutionalism emphasizes that this interplay between state-dependent and spontaneous legal developments (contingent on private interactions, culture and custom) underpins essential institutions within capitalism, such as property, money, contracts, corporations and markets (Hodgson, 2015). If law plays an integral part in capitalist societies, the potential for shifting the nature, goals or meanings of economic activity, and achieving enhanced equality, also have an expression in the legal sphere (Stryker, 2003).

This view implies a crucial conceptual distinction. Law is part of institutionalized power structures, but it is also an instrument for the exercise of power and an expression of power itself (Deakin et al., 2017); it is not just the mirror image of pre-existing power relations. The state’s power is manifested through the actions of public officials in the executive, legislative and judicial branches, which, under well-grounded rules of their time, make decisions that define policies and assign legal rights (Commons, 1959).

³ The sources of inspiration range from legally grounded institutional analysis e.g. Commons (1959) and Samuels (1989) – see Deakin et al. (2017) – to contemporary institutional political economy studies e.g. Chang (2002a) and Chang and Evans (2005) – see Coutinho (2017).

Similarly, the process of setting up systems of substantive rules, contracts, procedures, routines and practices institutionalizes policy goals. However, formalization is imperfect because there are always gaps between written rules, their interpretation and practice. The outcomes of state policy and legal choices are not neutral; they fit different purposes, benefit particular interests, and frame which economic (among other) performances are to be pursued (Samuels, 1989).⁴ Consequently, legal processes themselves become the arena of conflict and power relations, unraveling through negotiation, bargaining and compromising (Pistor, 2009).

A central contribution of legal institutionalism is to conceive of the opportunities for advancing policy agendas as associated with participation in lawmaking, regulation and contracts. This is a view in which it is claimed that law can (and must) be subject to intentional operationalization geared towards framing adequate and legitimate institutional arrangements in public policies (Coutinho, 2017). It follows that the scope for shifting power relations in the economy largely depends on (public) actors discovering how to effectively use the law to advance their goals (Deakin et al., 2017). Therefore, successful policies are also contingent upon experimentation in the legal domain.

3.3. The entrepreneurial state

Research on the entrepreneurial state challenges the received wisdom that business is the only risk-taker (Mazzucato, 2013). It builds on scholarship on industry dynamics, which offers a more refined view of entrepreneurial phenomena, distinguishing progressive and regressive characteristics affecting new firm entry to industry and performance (Vivarelli, 2013). Firms act as profit-seekers driven by expectations about future opportunities that become clearer as the innovation process unfolds (O'Sullivan, 2006). Recognizing that public investments are a trigger for economic and technological opportunities, Mazzucato (2013, 2016) has drawn attention to the roles that different types of public actors and public finance may play in the risk landscape (Fig. 1).

The concept of entrepreneurial state refers to the public sector's "willingness to invest in, and sometimes imagine from the beginning, new high-risk areas before the private sector does" (Mazzucato, 2016, p. 149). It supports an interpretation of the history of most important contemporary technological breakthroughs, by showing that strategic public investments often arrive early, absorbing major uncertainties and long-term risks. They ultimately enable new industries to be taken over by business only once profits are apparent. Examples include the ICT revolution (Block and Keller, 2011), biotech (Lazonick and Tulum, 2011; Vallas et al., 2011), and emerging renewable energy industries (Mazzucato and Semieniuk, 2017).

As far back as the 1930s, Schumpeter (1934) considered that new markets created through innovation depended on inventiveness (creating 'new combinations'), entrepreneurship (envisioning business opportunities and bringing inventions to market) and capital (providing finance so entrepreneurs could control the production factors needed). Noting that these roles may not necessarily be conflated in the same individual or entity, Schumpeter made it clear that financiers are those who put their capital at risk, not entrepreneurs as such.⁵ Therefore, in Schumpeterian terms, especially in the initial capital-intensive stages of technology development, the state is a leading financier in contemporary market economies, acting both as a capitalist (risk-taker) and an entrepreneur (opportunity-driven). In light of this, Mazzucato (2016) has argued that the role of the state is better understood as co-creating and shaping

⁴ In this regard, legal institutionalism is consistent with the political economists' remarks that the promotion of economic development requires institutions to fulfill specific functions, which are better served by certain institutional forms (Andreoni and Chang, 2019).

⁵ As Schumpeter (1934) stressed, even when entrepreneurs invest their own resources in R&D, they absorb the risks of failure in the capacity of financiers, not entrepreneurs.

markets, and not only fixing them.

Further insights derived from mission-oriented R&D literature indicate that public risk-taking has a pervasive space dimension. Public funding spans the entire innovation chain, reaching both the supply-side – from basic to applied research and early-stage financing of companies downstream – and the demand-side (Mowery, 2009; Foray et al., 2012). Public resources operated in this way may play a catalytic role if, beyond direct funding, policymakers embrace a systemic approach that includes complementary measures such as regulation and taxes (Ergas, 1986).

Analysis of the entrepreneurial state leads to the argument that neglect of the nature of public investments has created a pattern of socializing risks while privatizing rewards, preventing innovation policy from realizing its full potential (Mazzucato, 2013, 2017, 2018; Lazonick and Mazzucato, 2013). In turn, acknowledging state risk-taking implies accepting that most attempts to create new businesses are likely to fail. Occasional successes come through trial and error. As a result, scholars have pointed to the advantages of conceiving public investments as a portfolio (Mazzucato, 2013; Rodrik, 2015; Stiglitz, 2015) so the state can also benefit from the potential financial rewards, recover from losses and continue to fund further rounds.

3.4. The legal-institutional dimension of market co-creating and shaping

Attention to the institutional and legal foundations of markets can reveal an essential dimension of policy-making, implementation and assessment. Legal institutionalism sheds light on state agencies' ability to create, change, use and sustain legal rules, procedures and contracts that contribute to socially desirable and democratically legitimized innovation policy objectives. Admitting that institutionalization is the product of state design and of shared norms and values at a point in time, this approach makes it possible to consider those legitimation processes underlying a risk-taking state. Thus, the conditions for enabling adequate institutional alternatives and consensus-building become more important than determining the constraints to market creation and shaping.

Consistent with the above, a dynamic and context-dependent analysis of the different forms and functions of legal and institutional arrangements takes priority over a static comparison with the best set of rules for optimal markets. Such analysis provides for a more nuanced appreciation of the limits, tensions and possibilities of public and private collaboration throughout the innovation and policy processes. Integrating these ideas into this new framework opens the way for new analytical tools that can be used to deal with real-world policy challenges, such as the potential mismatches between the risks taken and rewards realized by actors participating in public-private partnerships.

4. Socializing the risks and rewards of public investment: elements for a portfolio approach

The allocation of risks and rewards in public-private partnerships offers a unique lens through which to observe the division of innovative labor, perceptions about the 'failure' and 'success' of public investments, and expected returns. It makes it possible to look into actual mechanisms whereby the state, on behalf of citizens, seeks to reap a share of the financial rewards and, thus, use instruments to appropriate returns that go beyond the prescriptions of market failure theory. Nevertheless, certain limitations need to be recognized, given that public and private contributions are closely intertwined (Nelson, 2005).

Because innovation is inherently uncertain, and investments have no guaranteed return, enhancing public control over any arising rewards is a necessary, albeit secondary, condition for legitimizing the state's role in creating and shaping markets. Within a framework that sees public agencies as capable of absorbing high technological and market risks, there is a valid expectation that the fruits of successful public finance will serve the taxpayers and therefore provide a rationale for also socializing the financial rewards achieved (Lazonick and Mazzucato, 2013).

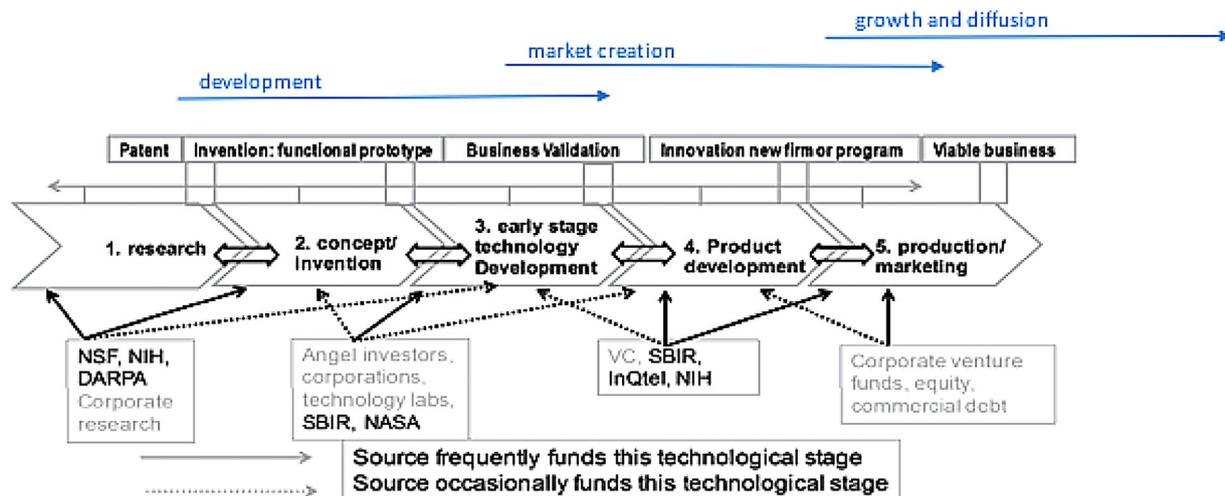


Fig. 1. Sources of public and private finance along the innovation chain (US).

Source: Authors' adaptation of underlying figure by (Auerwald and Branscomb, 2003). NSF, National Science Foundation; NIH, National Institutes of Health; DARPA, Defense Advanced Research Projects Agency; SBIR, Small Business Innovation Research Program; NASA, National Aeronautics and Space Administration; InQtel (venture capital firm funded by the CIA, Central Intelligence Agency).

Market failure theory assumes that the state already recoups rewards via job creation, knowledge spillovers, increased living standards and tax revenues. However, it ignores concrete limitations in those mechanisms. Patents granted broadly and upstream end up blocking or slowing down knowledge spillovers, either of which can harm follow-up innovations (Mazzoleni and Nelson, 1998). Similarly, when companies avoid or evade tax payment, the state is unlikely to reap enough fiscal surplus to enable its redistributive function. Furthermore, the mainstream approach has no explanation for a variety of instruments that public agencies eventually consider in seeking to link risks and financial rewards. A market co-creating and shaping approach incorporates the view that these government initiatives are an intrinsic dimension of investment process and strategy.

As this framework focuses on innovation policy that is oriented towards critical societal needs, the socialization of rewards can be understood as an attempt to balance financial returns and broader economic and social benefits. Thus, the framework enables a distinction to be made between two sets of complementary, yet sometimes conflicting practical measures: profit-sharing and conditionalities.

4.1. Profit-sharing policy instruments

In neoclassical economics, business profits often mean the “rewards for innovation and risk-taking” (Samuelson, 1997). Conversely, if the state plays a lead entrepreneurial (investor-of-first-resort) role, it would be reasonable for public agencies to share in the profits. Claiming a share of the financial gains of public investments, beyond taxation, makes it possible to compensate for the inevitable losses (given the high uncertainties involved) and continue to invest in future innovation. Therefore, it could help to create a revolving fund, as in the case of private venture capital portfolios.

One advantage of profit-sharing mechanisms over taxing concerns the potential for attaining a more stable source of public funding and having a higher impact on the direction of innovation. A revolving fund allows public agencies to enhance their discretion over, and independence from, budget funds. Furthermore, governments can design and manage the recoupment of revenues more flexibly than they could through taxes. Besides being essential for the alignment of private and public actor's interests, flexibility prevents harm being done to supported firms (Enke, 1967). Having the state retain a share of business profits arising from successful innovations can help to build consensus around the public sector's role and performance (Windus and Schiffel, 1976). As a public portfolio leaves a traceable record of

supported projects and firms, and gains and losses, it offers an objective measure of success against which public managers can be held to account (Mazzucato, 2016).

Failure of public funding, for any reason, is often considered indicative of an inability to ‘pick winners’ or ‘distortion’ of (otherwise optimal) markets (Owen, 2012). Yet many of the successes go unnoticed and even result in public rewards being privatized. The US Department of Energy (DoE) attracted criticism for providing a guaranteed loan of \$528 million to the solar-power start-up company Solyndra, which went bankrupt once the price of silicon chips fell dramatically, leaving taxpayers to pick up the bill (Wood, 2012). However, few critics acknowledged that a similar guaranteed loan (\$465 million) supported Tesla for the development of the Model S electric car, which led to success; even fewer have ever questioned why the government accepted early payment of the underlying loan (earning \$12 million back) instead of negotiating stock options that could have been worth almost \$1.4 billion (Woolley, 2013). Had the DoE chosen the stock options, the royalties retained could have not only covered the Solyndra losses many times over but also been used to continue to fund promising ventures (Mazzucato, 2013) while signaling the importance of government's high-risk funding for achieving renewable-energy technologies.

The above example also exposes the set of strategic decisions that policymakers face regarding the selection of profit-sharing mechanisms suitable for each context. Table 1 illustrates how the design of financing instruments for supporting innovation downstream (the first two columns) entails choices regarding how and to what extent public investors may be able to capture financial rewards (third and fourth columns).

Profit-sharing mechanisms may include: repayable grants with profit-sharing via royalties on sales or equity stakes; public venture capital funds enabling royalties on equity; debt financing convertible into equity; and other sorts of fund-mixing elements of equity and debt (OECD, 2014). Through these various instruments, the state seeks to attract private investments by mitigating the risks of innovation. A critical distinction concerns the risk spectrum. While grants, for instance, may address fundamental uncertainty and technology risk at early-stage R&D projects, the stakes are higher for state-owned venture capital, because it reaches the more capital-intensive stage of technology development in which, though less uncertain than upstream, the market risks are extremely high. Consequently, the revenue basis upon which public and private actors agree to share is significantly different, ranging from a low-value basis (IPR) to high-value (capital gains), as the Solyndra vs. Tesla case illustrates.

Table 1
Existing policy instruments for financing innovation that allow for profit-sharing (selected examples).

Financing instruments	Types	Key features	Returns to funding agency	Some country examples
Debt financing	Repayable grants/ Advances	Repayment required, partial or total; could be granted on the basis of private co-funding	Royalties of IPR licensing or levy on sales	Repayment grants for start-ups from 2014 to 2016 (New Zealand)
Debt/equity financing	Mezzanine funding	Combination of several financing instruments that incorporate elements of debt and equity in a single investment vehicle	Interest rates plus spread	Credit line mezzanine financing (Portugal)
Equity financing	Venture capital funds and fund of funds	Funds provided by institutional investors (e.g. banks, pension funds) to be invested in firms at early-to-expansion stages; referred to as patient capital, due to lengthy time span for exiting (10–12 years)	Equity stakes	Innpulsa (Colombia), National Innovation Fund – Venture Capital Fund (Czech Rep.), Corporate Venture Programme (France), Yozma Fund (Israel), Scottish Co-Investment Fund (UK)
Public procurement for R&D and innovation services	(pre-commercial procurement of R&D)	Demand for technologies or services that do not exist yet; or purchase of R&D	IPR of research results; agency can opt to shift ownership to contractors and establish licensing conditions	Entrepreneur Growth Strategy (Estonia), Strategy for Public Procurement (Sweden), Small Business Innovation Research (SBIR) Program (US) and SBIR-type of programmes (UK)

Source: Authors' adaptation of OECD (2014, 2016).

The choice of policy instrument or 'mix' should also consider practical issues. Through grants, for example, public agencies can benefit from wide possibilities to control the course of the project (Rothgang et al., 2003); however, the exposure to rent seeking, misallocation and abuse, is substantial. In contrast, venture capital allows the creation of new business actors, or the strengthening of existing ones, who are willing to invest in socially desirable areas. Here too there is high risk in relation to the successful exit and public agencies are required to incur in great monitoring efforts (Rothgang et al., 2003); an excessive focus in short-term profits is also a risk. It is important, therefore, that the selection of instruments takes into account not only the policy objectives, but also the capabilities of public agencies to deal with the issues mentioned above. In practice, the main strategic orientation that derives from our framework, concerns the composition of a public investment portfolio that allows to diversify both the risk and reward potential across different types of projects, firms and industries, rather than 'picking winners' by making bets on a few firms ex ante. This requires the state choosing a broadly defined direction—such as the digital or green revolution—supporting the basic infrastructure while also providing the patient long term funding to those businesses. In this context, the issue is not funding particular sizes of companies (e.g. SMEs) but any company—including larger ones—willing and able to invest and innovate towards meeting a public goal such as the development of carbon neutral regions.

A key question is how long the state should stay in the investment, and when the optimal exit strategy might be. Ensuring investments with different maturation times (including those in large companies with more stable dividends), and exit strategies that allow governments to stay long enough to recoup rewards proportionally to the risks taken, is crucial to sustain continuous long-term public investments.

Although state-owned banks adopt many profit-sharing instruments, the market-failure approach often takes them as distortions. From a market co-creating and shaping perspective, public financial institutions are authentic mechanisms for socializing the risks and rewards of investments (Mazzucato, 2013). By definition, banks are structured to operate with an expectation of return and to manage investments through a portfolio approach. They retain equity when running venture capital support while eventually benefitting from windfall gains, as corroborated by evidence on state-owned banks in Brazil, China and Germany (Mazzucato and Penna, 2016). Alternatively, even less risky investments ensure a reward; for example, when involving loans or corporate bonds. Besides, for state-owned banks typically operating a wide range of financing instruments, it is plausible to assume that they are also in a privileged position to innovate in the design of those instruments so as to compensate for the risks absorbed. Using a market co-creating and shaping framework ensures that questions are asked about what lessons can be drawn from development banks to help the broader range of public agencies that fund innovation to develop a coherent portfolio approach.

Such an approach also allows us to envision new challenges for successful policy implementation. One key issue is to enable long-termism through adequate reward structures. Another, is to ensure a recouping state does not shy away from reinvesting with a clear public purpose. Developing institutional and governance structures that are fit for these is yet another area that deserves attention.

4.2. Policy instruments involving conditionalities

Recognizing the importance of balancing risks and financial rewards does not mean neglecting the core objective of innovation policy, which is to generate tangible economic and social benefits. A market co-creating and shaping framework departs from the premise that social returns will naturally emerge and shed new light on actual institutional designs, policies and practices that contribute to a productive environment for innovation. In this context, typical industrial policy measures such as conditionalities tied to the allocation of public funds can be understood as active attempts to enable innovation to flourish while steering benefits

directly to society. Examples of such conditionalities are the pricing of final goods and services, knowledge governance and reinvestment in innovation and local production, and these are discussed below.

4.2.1. Pricing

Supported innovations, especially essential public goods and services, must be affordable and accessible to fulfill an investor-of-first-resort role of the state. Otherwise, taxpayers may end up paying the taxes that enabled public investments in R&D and infrastructure, and again for high prices when these downplay the state's contribution to the former (Alperovitz and Daly, 2009). Pricing regulations for monopolistic industries of the kind enacted as a law in the United States, but not yet implemented, can mitigate this problem. The 1980 Bayh-Dole Act includes a pricing cap provision named 'march-in rights.'⁶ This rule provides public agencies that supported an invention with powers to license it to a third party if, among other causes, the patent-holder does not take steps to achieve practical use. An example of the rule in action is that the requirement on the practical application of research results regarding new drugs that benefitted from public funding demands 'reasonable' (accessible and affordable) prices (Davis and Arno, 2001).

4.2.2. Knowledge governance

The history of mission-driven public finance shows that the creation and diffusion of knowledge in priority areas were not spontaneous, but heavily reliant on the decisions of public funding agencies. The US military sector illustrates that the use of public procurement can furnish the government with leverage that enables it to steer the development of strategic technologies under an open science and collaborative environment (Mowery, 2009). Ensuring that information was available and accessible, procurement stimulated dynamic and persistent exchanges among and within multiple organizations, favoring learning and high spillover effects. In any case, the scope for positive spillover depends on the stage of technology development – declining as technologies mature – and the design of missions and projects in question: the more sectors involved, the higher the synergies (Mazzucato, 2018).

4.2.3. Reinvestment

Instead of assuming that economic growth and job creation will ensue, a market co-creating and shaping approach sees the materialization of those expectations as associated with the sustainability of investments in innovation and local production. If business profits are hoarded or mainly used for short-term, low-risk and high-return financialization purposes, the expected effect on employment will be reduced. This interpretation offers a foundation for steering business investments into productive economic activities. A real alternative is to enforce regulations establishing obligations for firms to reinvest in innovation. Since the late 1990s, Brazil has implemented legislation mandating public and private companies in previously privatized sectors to reinvest a share of their profits into public R&D funds.⁷ A similar obligation gave rise to the Bell Labs when US antitrust authorities ordered AT&T to invest in R&D in order to continue benefitting from a telephone industry monopoly. There is also plentiful evidence of governments taking a more active stance towards local manufacturing, which was closely linked with the opportunities for job creation. Furthermore, the Bayh-Dole Act brought a requirement for products embodying the results of publicly funded R&D to be manufactured substantially in the United States.⁸

4.2.4. Other conditions

Baumol's (1990) work on the different types of entrepreneurship showed that encouraging 'productive' activities may not be enough to

deter or block the ones that are 'destructive'. In this regard, recognizing that the state can act as a leading investor gives new meaning to initiatives to protect and manage its (capital and intangible) assets; however, such initiatives find no justification in a market failure framework. Managers of public venture capital funds, like their private counterparts, contemplate the option of upholding preferred stocks or golden shares in individual firms as a way of protecting state-owned capital assets. Preferred stocks enable priority in receiving dividends, high rates and warrants, whereas a golden share empowers the vetoing of key corporate events (mergers, liquidations, asset sales, etc.) when these are deemed detrimental to society. The UK Government has widely adopted both types of measures to avoid hostile takeovers of privatized firms and foreign companies gaining full control (Jones et al., 1999). However, in the context of active entrepreneurial states, such measures have received renewed attention, as has the protection and management of intangible assets held in the public sector. Because of the UK government's Industrial Strategy, the Treasury has published a report on this matter (HM Treasury, 2018).

As the literature on the entrepreneurial state and various scholars propose, the mix of profit-sharing policy instruments and those involving conditionalities can be re-interpreted as incipient, often ad-hoc attempts to fulfill the reward function of a portfolio approach to public funding. By analogy with business management practices, seeing public investments as a bundle, instead of individual units, means spreading the risk across individual programs, R&D projects, directions of search and types of firms, enabling exploration of multiple pathways while enhancing the chances of success (Stiglitz and Wallsten, 1999; Mazzucato, 2013). Our framework highlights the importance of diversifying not just risks, but also reward mechanisms, thus moving beyond the market-failure approach and providing decision-makers with core elements with which to devise a portfolio strategy. This makes it possible to assess these practices more systematically and derive the relevant lessons that can guide better policies.

4.3. The legal and institutional foundations of symbiotic ecosystems

So far, the analysis has indicated economic reasons for balancing risks and rewards of public investments, showing that they involve, among other factors, the mobilization of resources in the legal domain, for example, through attempted changes in legal rules and contracts. At this point, it is useful to widen the view of the role of legal institutions in the economy and society. The fact that their development is dependent on state powers adds to the explanation of how and to what extent the socialization of risks and rewards will occur.

One consequence of the market co-creating and shaping framework is that attention on exchanges among private owners shifts to market interactions, especially public-private partnerships for financing innovation. Accordingly, the relevant analytical and policy problem regarding the functions of underlying contracts and rules is the extent to which an institutional environment favors and sustains widespread collaborations, dynamism and market creation. The equity of the distribution of rewards of public-private partnerships and the rules that fit that purpose are essential dimensions of that process.

Research on developmental states and legal institutionalism points towards seeing the risk-reward nexus as a social, political and legal construction, whereby the state plays an active and constitutive role (Polanyi, 1944; Evans, 1995; Deakin et al., 2017). The framework makes it possible to locate the decisions regarding the adoption of profit-sharing policy instruments and conditionalities in the dynamics and tensions among state powers, within and across public organizations, and, in between these, the private sector and citizens. In this way, the framework goes beyond emphasizing the importance of stability, clarity and predictability of the rules underpinning economic activity as devices for mitigating uncertainties. It adds that signaling values such as trust and fairness are functions that the law should play. Therefore, an institutional

⁶ 35 U.S. Code § 203 ("March-in rights").

⁷ Law 11540/07 enacted the National Science and Technology Development Fund (FNDCT) and sectoral R&D funds while establishing a mandatory requirement for profit reinvestment in R&D in selected areas.

⁸ 35 U.S. Code § 204 ("Preference for United States industry").

environment only supports the risk–reward nexus of public–private partnerships when the key stakeholders perceive it as such.

Rather than natural or neutral, as construed in neoclassical economics, legal and institutional frameworks mediate private and public appropriation of rewards. In this sense, the ‘winner takes all’ mindset results from political and legal choices, as illustrated by high-tech industries in the United States. Besides the changes in IPR legislation, the emergence of a special court to handle patent appeals meant that courts could play an active role. However, it is debatable whether expanding patent subject matters into living organisms was necessary for attracting business into biotech (Eisenberg, 2006). In ICT, judges and regulators loosened copyrights and privacy regulations - justified by freedom of speech but resulting in a de facto industrial policy (Chander, 2013). Similarly, publicly funded activities in defense and aerospace, such as those targeting low-Earth orbit, seem to be moving toward expanded private appropriability (Mazzucato and Robinson, 2018), along with efforts to create more equitable public–private partnerships.

To the extent that financial relations involve power, the outcomes depend on the unfolding of negotiations, bargaining and compromising (Pistor, 2009). The Bayh-Dole Act originally contained a provision that entitled the US Treasury to recoup a share of the profits realized upon publicly funded research, but only above a certain threshold. Nevertheless, this provision was removed due to the economic downturn, political reasons and concerns regarding the bureaucratic costs for implementation (Herder, 2008). In contrast, Israel exemplifies an investor-of-first-resort state that co-evolves with legal and institutional structures that enable public rewards to be enhanced. The Innovation Law of 1984 requires successfully supported projects to repay royalties on sales to the Innovation Authority. Israel is also famous for the positive experience of the government’s performance as a venture capitalist through the Yozma Fund, which yielded returns via equity (Avnimelech, 2009). These various arrangements across and within countries reinforces the need to deepen the knowledge on the instruments appropriate for each context to support strategic decision-making.

While one could interpret some of these policies using market failure theory (for example, asymmetric information causing incomplete contracts among private actors), it is hard to justify the bureaucratic burden of profit-sharing contracts involving venture capital or royalties purely on those grounds. The function-based approach to systems of innovation offers a more useful explanation, underscoring legitimization processes as a prerequisite for the emergence of new technology innovation systems (Bergek et al., 2008). However, the focus on individual technologies, and on the premise that business drives innovation offers limited analysis of the challenges for leading public agencies to shape how their role as investors can be legitimated. A market-co-creating and shaping framework shed light on the development of this role, because within it is the concept that governments’ efforts to build more equitable public–private partnerships are an integral part of legitimacy-building.

Mazzucato (2013) has distinguished between two ideal types of innovation ecosystems – symbiotic and parasitic. Derived from a comparison to biological communities, the term ‘innovation ecosystem’ describes the functionality of the economic dynamics of the network of relationships between the multiple actors and institutions collaborating for R&D and innovation. The term complements the notion of ‘systems of innovation’ by highlighting the nature of those relationships. An innovation ecosystem is symbiotic if it is rooted in mutually beneficial legal relationships, in which increased profits accruing from innovation enable public and private investors to replenish funds and continue to invest in new rounds (Mazzucato, 2013). A crucial ingredient is the perception that the environment at stake is virtuous and equitable. A parasitic ecosystem is rooted in legal relationships in which one actor benefits at the expense of the others. It tends to expand the private appropriability of financial gains obtained with public support, thus favoring ‘winner takes all’. The symbiotic/parasitic dichotomy is useful in any analysis of current systems and for informing the direction of change.

Table 2 summarizes the features of formal rules and contracts sustaining symbiotic and parasitic ecosystems. While the contrast suggests two opposite poles, the reality is more complicated. Between the two, there is a continuum of hybrid ecosystems rooted in public - private contractual relationships that combine the two types. Hence, one can consider a hypothetical spectrum of change between the two extremes.

The concrete examples in this section indicate limits and possibilities for state action institutionalizing, through the law, more equitable reward structures. Such examples are a start towards identifying the conditions that encourage symbiotic ecosystems. Analysis of these and other experiences could lead to useful lessons for public agencies in how to design new policy instruments and shape symbiotic relationships. After all, experimentation is crucial to the accumulation of the powers to do this effectively.

5. Conclusion, main implications and areas for future research

In this paper we have presented a new approach to innovation policy that complements the market-failure rationale. Public investments are at the center of the innovation process because of their role of co-creating and shaping markets with businesses. Also, legal rules, procedures and contracts play a constitutive role and the state’s action is strategic for steering the institutional environment in those directions that allow for the realization of socially desirable policy goals. By making explicit the leading role of the state as an investor and enabler of institutional change, this approach allows public agencies to be conceived as actors entitled to seek to appropriate a share of the rewards of the innovations to which they contribute. In other words, it becomes possible to understand and analyze how governments, when acting along the innovation chain, may attempt to socialize both the risks and rewards of public investments – a question that has been only narrowly considered under a market-failure framework. The analytical and policy implications suggest interesting avenues for future research.

Recognition of the risk-taking entrepreneurial role of the state provides initial justification for public funding agencies’ attempts to recoup some of the financial rewards realized, beyond taxation. Sharing rewards with private actors enables a more ‘portfolio’ mindset – where the upside is used to cover the downside – and more stable funding to serve citizens’ needs. Emphasis on the legal-institutional dimension sheds light on additional functions for measures such as royalties, equity stakes, pricing capping mechanisms or other conditionalities, which remain invisible in the mainstream approach. In democratic societies, these can be understood as means of attempting to balance asymmetric power relations, tensions and conflicting views among multiple stakeholders, while building a shared notion of the value and legitimacy of the state. On the basis of this conception, we have refined the notion of innovation ecosystems in terms of the risk – reward nexus in public – private partnerships. While accepted equitable agreements lay the foundations for symbiotic ecosystems, parasitic ones encourage ‘winner takes all’, at the expense of society.

We identified two sets of legal measures through which public agencies could seek an adequate return on investment. Profit-sharing enables recoupment of potential financial gains in proportion to the risks undertaken. Conditionalities target tangible benefits to society regarding the pricing of essential goods and services, access to and diffusion of new knowledge, job creation, etc. Although not meant to be exhaustive, this distinction reveals several legal instruments and practices fitting the two broad types of measures, instead of a ‘one-size-fits-all’ approach. This aspect highlights an opportunity for further thinking on new instruments – and corresponding governance schemes – capable of ensuring that the state, representing the public, has the possibility of capturing a fair share of rewards. Pursuing a better understanding of the functioning of and interactions between those measures in governments’ policy mixes may also be a worthwhile path.

Table 2

Features of the legal underpinning of the distribution of rewards in public–private partnerships: parasitic versus symbiotic ecosystems (selected examples of how public actors can capture rewards).

	Parasitic	Symbiotic
Risk - reward nexus	Imbalanced	Balanced
Private appropriation	Favouring private appropriability Rewards captured as profits and capital gains (increase in asset value), but they lead to 'winner takes all'	Favouring public appropriability Profits and capital gains still relevant, but shared more equitably among actors who contributed to the innovation process
Public appropriation	Passive	Active
Via conditionalities (legal measures to ensure tangible benefits to society)	Rewards are natural, spontaneous and gradually accrued from competition through: <ul style="list-style-type: none"> ■ Improved living standards for consumers; ■ Diffused benefits of 'public good' provision and positive externalities; ■ Knowledge creation and spillovers; ■ Job creation 	Rewards targeted, steered and sustained through conditionalities on: <ul style="list-style-type: none"> ■ Pricing controls for public goods/services (access and affordability to all); ■ Targeted, mission-driven benefits (qualitative requirements for 'public good' provision) ■ Knowledge governance (access to and diffusion of the crucial knowledge for tackling societal challenges) ■ Local manufacturing to stimulate productive entrepreneurship and job creation within the country/region ■ Profit reinvestment on R&D to continuously stimulate productive investments and virtuous ecosystems ■ Avoidance or blocking of dilution/liquidation of state-owned capital assets (preferred stocks, golden shares etc.)
Via profit-sharing (legal measures to enhance financial rewards to the state)	Limited to the taxation of profits or capital gains	Beyond taxation, financial rewards recouped via: <ul style="list-style-type: none"> ■ Reimbursement of public funds (partial or total); ■ Public sharing of profits (e.g. royalties, levies on sales); ■ Public sharing of capital gains (e.g. equity convertible bonds or hybrid financing instruments mixing equity and debt)
Legal framework	Allows public funding and assumes recoupment will follow	<ul style="list-style-type: none"> ■ Allows public funding plus recoupment (via conditionalities and profit-sharing) ■ Allows public funding and makes recoupment mandatory

Source: Authors' elaboration.

The legal-political processes that influence the institutionalization of initiatives to socialize rewards offer another way of grasping the complexity behind risk-and-reward distributions. Recognizing this processes are intertwined, and that the state power is intrinsic to them, uncovers key challenges. Consensus-building takes time and effort, as it involves multiple actors, asymmetric powers, different interests and actors operating under various rules etc. Potential solutions will not always work: they reflect the possible agreement. Thus, experimentation, learning and flexibility are critical for institutional and legal design.

The benefits of advancing a market co-creating and shaping framework for innovation policy seem clear in the face of contemporary societal challenges. While empirical studies could help to enrich and expand the analytical tools discussed in this paper, this new approach also offers guiding principles for policy design, implementation and evaluation.

First, our analysis suggests the importance of improving the targets of public investments to develop a clear public purpose and to state expected benefits to society through defining missions, goals and measures of progress. Extending the use of mission-oriented initiatives, and nurturing the capabilities to do so, are important for legitimizing a risk-taking state; however also required are adequate institutional mechanisms to enable open and broad participation in deliberations regarding the directions of change (Stirling, 2008).

Second, the framework indicates the advantages of pursuing a portfolio approach to structure long-term public investments, as it allows public agencies to spread the risks while ensuring an upside in the event of success that could provide for a continuous funding source. A direct nexus between risks and rewards is instrumental in forming and managing a portfolio. Thus, policymakers should aim to develop a strategy for achieving a balanced risk–reward nexus, which defines priorities and brings coherence to the measures to recoup rewards while keeping in view their public missions.

Third, the framework emphasizes the importance of contemplating the design of legal and institutional structures that underpin an equitable sharing of rewards between actors in the public and private sectors, as part of the process of market creation and shaping. Public agencies should be allowed to come close to the private sector and explore the different legal instruments available, in order to identify which are more

appropriate for building symbiotic partnerships. Besides encouraging creativity, this may involve raising awareness of, and negotiating with, actors in the state legal apparatus, such as legislators, regulators, judges and auditing bodies.

Together, the above-mentioned aspects suggest the need to promote the development and accumulation of capabilities in the public sector. Empowering governments to design, implement and assess practices for dealing with the risk–reward nexus is the key to shifting the contemporary pattern of socializing the risks while privatizing the rewards. Only appropriate capacity-building can invigorate hopes for inclusive, innovation-led growth.

To some extent, the success of innovation policies led by entrepreneurial states depends on the responses that stakeholders may provide to the questions we have posed in our framework. However, it should be noted that this approach assigns an important role to contextual factors. This means that risk-taking capacity in the public sector, missions with a clear public purpose and that are outcomes of participatory political processes, robust but flexible legal and institutional frameworks, and continuous reinvestment of public rewards are some of the preconditions for effective implementation (Laplane, 2019). While these cannot and should not be taken for granted anywhere, the degree to which such conditions may be present (or lacking) in various developed and developing country contexts is expected to differ. While it is evident that developing countries with weaker states may have greater challenges in developing public sector capabilities, it is also true that they have more of a history in considering conditionalities attached to foreign direct investment (Chang, 2002b). Such conditionalities could be transformed to be just as much about innovation as they are currently about development. In this sense, it is precisely developing countries that could benefit the most from a policy learning that enables socializing the risks and rewards of public investments.

Empirical research on incipient policy experiments in Brazil shows that, under certain circumstances, the above conditioning factors can be nurtured (Laplane, 2019). This evidence suggests that the framework is, therefore, applicable to developing countries. Future research should expand the analysis of the concrete experiences at different settings, including developing countries, to enable more insights into the challenges and opportunities for successful policy implementation and

to enhance the explanatory power of the framework. Drawing the relevant lessons from existing experiences will be useful for building a richer evidence-base to inform decision-making and better practices.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Andrea Laplane: Investigation, Conceptualization, Writing - original draft, Writing - review & editing. **Mariana Mazzucato:** Conceptualization, Supervision, Writing - review & editing.

Acknowledgements

For helpful comments on earlier drafts, we would like to thank the two anonymous referees, as well as Maria Savona and Rocio Alvarez Tinoco from SPRU. We also thank colleagues at SPRU and IIPP for fruitful discussions at different stages of this research. Andrea Laplane was sponsored by CNPq-Brazil for her PhD at SPRU (University of Sussex) and also received a grant from the Doctoral School of the University of Sussex.

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