

Socialising the risks and rewards of public investments:

Economic, policy and legal issues

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Socialising the risks and rewards of public investments: Economic, policy and legal issues

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Abstract

This paper develops a framework for analysing the role of public agencies in making high-risk investments along the innovation chain, and asks 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 institutionalise rewards in a way that promotes 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.

Keywords: innovation policy; risk capital; entrepreneurial state; portfolio approach; public-private partnerships; legal institutions

JEL codes: O3, O38, K40

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1. Introduction

The last fifty years have witnessed the emergence of several disruptive technological innovations — from IT to biotech and, more recently, renewable energies — that have involved profound institutional changes and brought unprecedented levels of value creation. In this process, the idea that innovation is led by private entrepreneurs who benefit from publicly funded infrastructure and research due to the presence of ‘market failures’ has prevailed as a guide for innovation policy.¹

This view has justified the notion that business deserves to capture a large portion of the value of innovation as profits. From a societal standpoint, as long as the adequate framework conditions were in place, the advantages of optimal levels of public spending in research and development (R&D), confined to fixing markets, were apparent. It would naturally bring about ‘social returns’ such as better quality and cheaper goods and services, job creation and public goods (such as new knowledge), ultimately resulting in economic growth and positive fiscal impact.

As direct public funding increasingly moves from basic research towards the later stages of R&D and commercialisation — where the risks of technological and commercial failure are high but so are the expected financial rewards in case of success — it defies the economic rationale underlying private appropriability. Especially following the 2008 financial bailouts, a key question raised was whether governments would continue socialising the risks of investments, while rewards were privatised (Mazzucato 2013). With the IT-based technological revolution turning growing income inequality into a significant contemporary challenge (Piketty 2017), the debate on the distribution of rewards of public investments has become all the more urgent.

Meanwhile, the fierce competition for budgetary funds and rising pressures for effectiveness and accountability has led to some timid attempts at policy responses. In the United States, the original text of the Bayh-Dole Act from the 1980s established an obligation for companies whose products benefited from the results of publicly funded research to pay back a share of their profits to the Treasury (Herder 2008). While this particular effort did not translate into law, other institutional innovations and new financing instruments enabling public-private partnerships to share both risks and rewards started to appear there and elsewhere.

Attempts to obtain a more equitable agreement between actors in public and private sectors who contribute to the innovation process have coexisted with other initiatives seeking to steer and target more tangible economic and social benefits. Though still incipient, public agencies’ efforts to increase the strings attached to the use of public funds (including conditions on accessible prices, R&D collaborations and open science (Mowery 2009), reinvestment in R&D, and local production) reflect an increasing desire for a more concrete social return on investment than that assumed under a market-failure framework.

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

Nevertheless, only a few studies have examined governments' initiatives to capture a share of the financial gains and more compelling benefits to society beyond those that come from growth and, hence, increased tax revenue (Enke 1967; Windus and Schiffel 1976; Korn and Heinig 2004; Herder 2008; Sampat and Lichtenberg 2011). Most importantly, the sporadic attempts to find a coherent economic rationale for government recoument of financial rewards (as in Windus and Schiffel 1976) have lacked a framework that acknowledges and links these problems explicitly. Therefore, policymakers would find poor or no guidance.

Lazonick and Mazzucato (2013) made an important step towards filling this gap. They offered a comprehensive framework named the 'risk-reward nexus' to investigate the relationship between innovation and inequality, finding that the collective, cumulative and inherently uncertain nature of innovation processes enables the dissociation between the risks taken and rewards realised by different types of economic actors — workers, citizens (represented by the state) and shareholders. The authors focused on the strategies that allow financial actors to position themselves along the innovation chain and extract more value than they contributed to generate, at the expense of the other actors.

The present paper complements that study 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 realised 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 2013; 2016). 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-maximising agents and to assess their quality in terms of the potential for shifting the nature, goals or meanings of economic activity and organisation to deliver increased wellbeing (Stryker 2003). Bringing these economic and legal angles together creates a richer understanding of the complexities, complementarities and tensions underlying the dynamics of public-private partnerships concerning risk and reward distributions.

The paper has two main aims. One is to revise analytical tools that help to systematise challenging aspects of contemporary innovation policy related to the risk-reward nexus, which the market failure approach overlooks. By conceptualising the institutionalisation of reward structures as a social, legal and political process — rather than an optimal end-point — the new framework helps researchers and decision-makers identify some of the relevant dilemmas. The second aim is to advance knowledge that can guide better policy practices towards socialising 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).

Section 2 reviews the market failure approach to innovation policy and its main shortcomings. Section 3 introduces three bodies of literature that lay the foundations for orienting a new approach: (a) the developmental state, (b) legal institutionalism and (c) the entrepreneurial state. We consider the role of legal institutions underpinning economic structures, showing that legal

and economic action and institutional design are interdependent. New functions of legal rules and contractual relationships become apparent in the co-creation and shaping of markets and the underlying power relations. Section 4 asks how the state can capture a share of the rewards, on behalf of citizens, that better reflects its lead role as a risk-taker. Section 5 concludes, outlining analytical and policy implications, and areas for future research.

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

The neoclassical economic framework views innovation policy 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 labour and capital inputs produces new products and services. As the primary organiser 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 and companies are in a better position to capture returns.

The expectation of achieving high rewards through public funding is vital for legitimising innovation policy. 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, 'public good' provision, knowledge spillovers and new jobs. Also, these benefits reflect a positive fiscal impact. Supposing that supported companies and individuals pay their due taxes, increased economic activity contributes to increased tax collection (the primary mechanism through which the state recoups a financial gain). While imperfections may block or reduce the optimal social rate of return, these are, again, just imperfections for government to fix. In sum, since this approach conceives public funding as 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 maximises economic welfare (Coase 1960), economic analyses of contractual relationships have mostly taken the underlying rules as given. Consequently, according to New Institutional Economics, the role of government, operating through courts, is at best limited to seeking efficient or aligned incentive structures that enable shareholder maximisation 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, the policy guidance derived from this approach deals with removing legal barriers and strengthening the incentives for profit-maximising entrepreneurs.

The market failure framework for innovation policy has attracted 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 what goes missing in the neoclassical economics static perspective. That approach examines existing landscapes (markets, sectors or technologies) and existing trajectories (whether firms are investing too little or too much in a given area), thus overlooking 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, which has been receiving increased attention.

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 consider an array of mechanisms, beyond taxation, that public agencies deploy in order to recoup a share of financial rewards of investments downstream; examples include royalties on IP 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 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 orienting a new approach for policy: the developmental state, legal institutionalism and the entrepreneurial state. The first draws on Karl Polanyi's (Polanyi 1944) insights on the nature of markets as socially embedded, stressing the active and endogenous role of the State in economic transformations. The second disentangles the collective processes through which legal arrangements frame, influence and sustain the organisation of the economy and the state. Lastly, research on the entrepreneurial state sheds light on the risk-taking role of public actors as a driver of the rates and directions of innovation.

Bridging these complementary and sometimes overlapping pieces of literature allows 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

Polanyi's description of the emergence of capitalism emphasises 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 conceptualised and documented such an intrinsic and active state leading profound transformations, such as those involved in the development of emerging East Asian economies (see Woo-Cumings 1999). This 'visible hand' acts as a capital provider and coordinator of industrialisation and technical change processes.

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

Another distinctive feature refers to the decentralised, 'networked' and flexible structures on which government relies (Ó Riain 2004), rather than the top-down, centralised organisation exemplified by the Ministry of International Trade and Industry (MITI) in Japan. Various types of public agencies operate by engaging in direct and close partnerships with businesses (Block and Keller 2011). Public officials with 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 collaborations or the spurring of existing ones. Hence, they are vital to the accumulation and diffusion of knowledge that drives technological change (Block 2008, pp. 172-179).

3.2 Legal institutionalism

Drawing on various traditions,² emerging studies 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 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 emphasises 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 institutionalised power structures, but 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 manifests 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).

Similarly, the process of setting up systems of substantive rules, contracts, procedures, routines and practices institutionalises policy goals. However, formalisation 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).³ Consequently, legal processes themselves become the arena of conflict and power relations, unravelling through negotiation, bargaining and compromising (Pistor 2009).

² The sources of inspiration range from legally grounded institutional analysis like those of Commons (1959) and Samuels (1989) (see Deakin et al. 2017) to contemporary institutional political economy studies (Chang 2002; Chang and Evans 2005); e.g. Coutinho (2017).

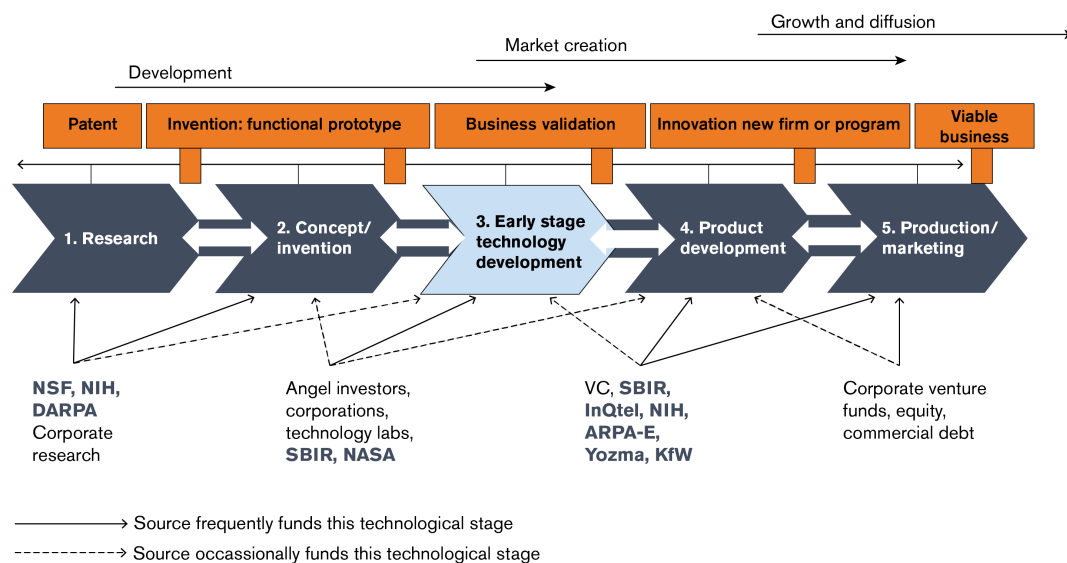
³ In this regard, legal institutionalism is consistent with the political economy’s remark that the promotion of economic development requires institutions to fulfil specific functions, which are better served by certain institutional forms (Andreoni and Chang 2019).

A central contribution of legal institutionalism is to conceive the opportunities for advancing policy agendas as associated with participation in law-making, regulation and contracts. It claims that law can (and must) be subject to intentional operationalisation 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). Recognising 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.

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



Source: Authors' adaptation of Auerswald and Branscomb (2003).

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, showing that strategic public investments often arrive early, absorbing major uncertainties and long-term risks, and enabling 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 energies (Mazzucato and Semieniuk 2017).

For Schumpeter (1934), 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 can control the production factors needed). Noting that these roles may not necessarily be conflated in the same individual or entity, Schumpeter clarified that financiers are the ones putting their capital at risk, not entrepreneurs as such.⁴ 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) argued that the role of the state is better understood as co-creating and shaping markets, not only fixing them.

Drawing further insights from mission-oriented R&D literature, public risk-taking has a pervasive space dimension. Public funding spans across 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 has argued that neglect of the public investment's nature led to a pattern of socialising risks while privatising rewards, preventing innovation policy from realising its full potential (Lazonick and Mazzucato 2013). In turn, acknowledging state risk-taking implies accepting that most of its attempts may fail. Occasional successes come through trial and error. As a result, scholars have pointed to the advantages of conceiving a portfolio of long-term public investments so the state can also benefit from the upside (Stiglitz and Wallsten 1999; Block 2008; Mazzucato 2013; Rodrik 2015), recover from losses and continue to fund the next 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 legitimised innovation policy objectives. Admitting that institutionalisation is the product of state design, but also of shared norms and values at a point in time, this approach makes it possible to consider legitimisation 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 this, a dynamic and context-dependent analysis of the different forms and functions of legal and institutional arrangements take priority over the static comparison with the

⁴ As Schumpeter (1934) stressed, even when the entrepreneur invests its own resources in R&D, she/he absorbs the risks of failure in the capacity of financier, not entrepreneur.

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 collaborations throughout the innovation and policy processes. Integrating these ideas into this new framework opens the way for new analytical tools to deal with real-world policy challenges, such as the potential mismatches between the risks taken and rewards realised by actors participating in public–private partnerships.

4. Socialising 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 for observing the division of innovative labour, 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 other returns that go beyond market failure theory’s prescriptions. Nevertheless, certain limitations need to be recognised, given that public and private contributions are closely intertwined (Nelson 2005).

Because innovation is inherently uncertain and investments have no guaranteed return, enhancing the public control over any arising rewards is a necessary condition for legitimising 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 a rationale for also socialising the financial rewards achieved (Lazonick and Mazzucato 2013).

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, harming 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 views these government initiatives as an intrinsic dimension of the investment process and strategy.

As this framework focuses on innovation policy oriented to critical societal needs, the socialisation of rewards can be understood as an attempt to balance financial returns and broader economic and social benefits. Thus, it can take advantage of a distinction 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 innovations. 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 potentials for attaining a more stable source of public funding and a higher impact on the directionality of innovation. A revolving fund allows public agencies to enhance their discretion and independence from highly competitive budget funds. Another advantage is that governments can design and manage the recoupment of revenues more flexibly than they could through taxes. Besides being essential to align private and public actors' interests, flexibility prevents harm to supported firms (Enke 1967). Moreover, having the State retain a share of business profits arising from successful innovations is an essential instrument for building consensus around the public sector's role and performance (Windus and Schiffel 1976). As a public portfolio leaves a traceable record of supported projects, firms, gains and losses, it also offers an objective measure of success with which to hold public managers accountable (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 privatised. The US Department of Energy (DoE) attracted criticism for providing a guaranteed loan of \$528 million to the solar-power start-up 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, according to some estimates (Woolley 2013). Had the DoE chosen the stock options, the royalties retained could have covered the Solyndra losses many times over and continued to fund promising ventures; this shows 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 (first and second 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 funding mixing elements of equity and debt (OECD 2014). Hence, besides the timing for the public sector to reap any rewards, a critical distinction concerns the revenue basis upon which public and private actors agree to share, ranging from low and IP to high-value (capital gains), as the Solyndra versus Tesla case illustrates.

Table 1. Existing policy instruments for financing business R&D and innovation that allow for profit-sharing

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 IP 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 funds of funds	Funds provided by institutional investors (e.g. banks, pensions funds) to be invested in firms at early to expansion stages; referred to as patient capital, due to lengthy time span for exiting (10 to 12 years)	Equity stakes	Innpulsa (Colombia), National Innovation Fund – Venture Capital Fund (Czech Rep.), COSME – Equity Facility for Growth (EU), Corporate Venture Programme (France), Yozma Fund (Israel), Scottish Co-Investment Fund (UK)
Public procurement for R&D and innovation		Demand for technologies or services that do not exist yet; or purchase of R&D services (pre-commercial procurement of R&D)	IP 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).

Although state-owned banks adopt many of these 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 socialising the risks and rewards of investments (Mazzucato 2013). By definition, banks are structured to operate with an expectation of return and managed through a portfolio approach. They have retained equity when running venture capital support while eventually benefitting from windfall gains, as evidence on state-owned banks in Brazil, China and Germany corroborates (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 the risks absorbed, with proportional financial rewards. A market co-creating and shaping framework asks 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.

A related concern is the types of structures of the state apparatus and governance schemes that are appropriate for delivering desirable outcomes. While there are analytical gains in assessing the risk — reward nexus in public — private partnerships, further thinking is required on the possible safeguards to mitigate policy risks, such as how to ensure a recouping state does not shy away from reinvesting in socially desirable areas.

4.2 Policy instruments involving conditionalities

Recognising the importance of balancing risks and financial rewards does not mean neglecting the purpose 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 innovations 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 — such as on the pricing of final goods and services, knowledge governance, and reinvestment in innovation and local production — can be understood as active attempts to steer benefits directly to society.

Pricing

Supported innovations, especially essential public goods and services, must be affordable and accessible to fulfil an investor-of-first-resort role for the state. Otherwise, taxpayers may end up paying for 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 US, but not yet implemented, can mitigate this problem. The 1980 Bayh-Dole Act includes a pricing cap provision named 'march-in rights'.⁵ 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. The requirement on the practical application of research results regarding

⁵ 35 US Code § 203 ('March-in rights').

new drugs that benefitted from public funding demands 'reasonable' (accessible and affordable) prices (Davis and Arno 2001).

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 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 actors, favouring 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).

Reinvestment

Instead of assuming that economic growth and job creation will ensue, a market co-creating and shaping approach sees the materialisation 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 financialisation 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 privatised sectors to reinvest a share of their profits into public R&D funds.⁶ A similar obligation gave rise to 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, with close links with the opportunities for job creation. The Bayh-Dole Act also brought a requirement for products embodying the results of publicly funded R&D to be manufactured substantially in the United States.⁷

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 'destructive' ones. In this regard, recognising that the state can act as a leading investor gives a new meaning to initiatives to protect and manage its (capital and intangible) assets, which find no justification in a market failure framework. 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

⁶ 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.

⁷ 35 US Code § 204 ('Preference for United States industry').

state-owned capital assets. Preferred stocks enable priority in receiving dividends, high rates and warrants, whereas a golden share empowers vetoing of key corporate events (mergers, liquidations, asset sales etc.), when deemed detrimental to society. The UK government has widely adopted both types of measures to avoid hostile takeovers of privatised 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 entrepreneurial state literature 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 programmes, R&D projects, directions of search and firms, enabling exploration of multiple pathways while enhancing the chances of winning a substantial upside if successful (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 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 the mobilisation of resources in the legal domain (for example, 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 socialisation of risks and rewards will occur.

One consequence of the market co-creating and shaping framework is that attention from 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 assessing the extent to which an institutional environment favours 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 the developmental states and legal institutionalism help to see this as a social, political and legal construction, whereby the State plays an active and constitutive role (Polanyi 1944; Evans 1995; Deakin et al. 2017). It 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 actors, and, between these, the private sector and citizens. That way, the framework goes beyond emphasising the importance of stability, clarity and predictability of the rules underpinning economic activity as devices for mitigating uncertainties. It

adds that signalling values such as trust and fairness are functions for the law to play. Therefore, an institutional 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 US. Besides the changes in IP legislation, the emergence of a special court to handle patent appeals meant that courts could play an active role. 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 defence 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.

As far as 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 Treasury to recoup a share of the profits realised upon publicly funded research, above a certain threshold, although this provision was removed due to the economic downturn, political reasons and concerns regarding the bureaucratic costs of implementation (Herder 2008). By contrast, Israel exemplifies an investor-of-first-resort state that co-evolves with legal and institutional structures that enable enhancing public rewards. 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 legitimation processes as a prerequisite for the emergence of new technology innovation systems (Bergek et al. 2008). However, the focus on individual technologies and the premise that business drives innovation offers limited analysis of the challenges for leading public agencies to shape legitimation of their role as investors. A market-co-creating and shaping framework sheds light on this, seeing governments' efforts to build more equitable public-private partnerships as an integral part of legitimacy-building.

Mazzucato (2013) distinguished between two ideal types of innovation ecosystems — symbiotic and parasitic. Inspired by 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. It complements the systems of innovation lens 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 favouring ‘winner takes all’. The symbiotic/parasitic dichotomy is useful for guiding analysis of current systems and informing the direction of change.

Table 2 summarises 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 institutionalising, through the law, more equitable reward structures. Still, it is a start towards identifying the conditions that encourage symbiotic ecosystems. Public agencies will need to learn which legal measures are available in order to innovate on policy instruments and shape symbiotic relationships, and experimentation is crucial to accumulate the powers to do this effectively.

Table 2. Features of the legal underpinning of the distribution of rewards of publicly funded innovations: parasitic versus symbiotic ecosystems (selected examples of how to capture public rewards)

	Parasitic	Symbiotic
Risk-reward nexus	Imbalanced Favouring private appropriability	Balanced Favouring public appropriability
Private appropriation	Rewards captured as profits and capital gains (increase in asset value), yet prompt to 'winner takes all'	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 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.

5. Main implications and areas for future research

This paper presents a new approach to innovation policy that complements the market failure rationale. Public investments are at the centre of the innovation process, co-creating and shaping markets with businesses. Also, legal rules, procedures and contracts play a constitutive role. This angle broadens the view on how governments, in acting along the innovation chain, may attempt to socialise both the risks and rewards of public investments. 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 realised, 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, that remain invisible in the mainstream approach. In democratic societies, these can be understood as a 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. The framework further distinguished 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 can 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, captures a fair share of rewards. Better understanding the functioning of and interactions between those measures in governments' policy mixes may also be a worthwhile path.

The legal-political processes that influence the institutionalisation of initiatives to socialise rewards offer another way to grasp the complexity behind risk and reward distributions. Recognising this as a collective process, where the state power is intrinsic, uncovers key coordination challenges. Consensus-building takes time and effort, as it deals with multiple actors, asymmetric powers, different interests, operating under various rules etc. Solutions will always be imperfect because 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. While empirical studies can help to enrich and expand the analytical tools, this new lens 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 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, is important for legitimising a risk-taking state. Yet it also requires 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. 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 emphasises 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 a dimension 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 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 socialising the risks while privatising the rewards. Only appropriate capacity-building can invigorate hopes for inclusive, innovation-led growth.

One avenue for future research is to explore relevant criteria for taking forward the taxonomy of risk-reward nexus. Also, expanding into case studies and in-depth empirical research could help illuminate market co-creating and shaping initiatives, and whether and how these co-evolve with the construction of symbiotic ecosystems. It could also help explain the circumstances under which legal structures and framings enable equitable public-private partnerships. Drawing the relevant lessons from existing experiences will be useful for building a richer evidence base to inform decision-making and better practices.

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