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Innovation Policy as Creating Markets, Not Only Fixing Them Implications for Complexity Theory

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Abstract

Successful innovation policies are those that actively create and shape markets, not only fix them. In the past this has been achieved through “mission-oriented” policies aimed not at fixing market failures or minimizing government failures, but rather on maximizing the transformative impact of policy. Countries around the world are currently striving to achieve innovation-led growth that is both inclusive and sustainable. For this to happen, public policy needs to support innovation and direct future activities. Innovation policy must focus on building more “symbiotic” (less parasitic) innovation “ecosystems.” This chapter discusses new types of policy questions needed to address the collective, uncertain, and persistent nature of innovation and posits four key areas: directing public policy, evaluating public policy, organizational change to accommodate risk taking and exploration, and the socialization of risks and rewards.

Introduction

The important thing for government is not to do things which individuals are doing already, and to do them a little better or a little worse; but to do those things which at present are not done at all. —John M. Keynes (1926, part 4)

Today, countries around the world are seeking “smart” innovation-led growth and hoping that this growth is more “inclusive” and “sustainable” than in the past (European Commission 2010). In this chapter, I argue that such a feat requires reimagining the role of government and public policy in the economy—funding not only the “rate” of innovation, but also envisioning its “direction.” This requires a new justification of government intervention that goes beyond the usual one of “fixing market failures.” It requires shaping and creating of

markets. To render such growth more “inclusive” requires attention to the ensuing distribution of “risks and rewards.”

Complexity theory is relevant here because innovation is a *collective* process defined by a *system* of heterogeneous public and private actors, interacting in different ways (Freeman 1995). It is both a fundamentally *uncertain* process, with most attempts ending in failure (Nelson and Winter 1982), and a *path-dependent*, cumulative and highly clustered (wave-like) process, characterized by fat-tailed distributions (Arthur 1989). Unfortunately, models of innovation continue to project the opposite: they are driven primarily by individual genius of “entrepreneurs” and are, at best, “facilitated” by the public sector; they are characterized solely by “risk” and are modeled as a “random walk” (with little persistence) which statistically appears as a Gaussian process. In this chapter, I discuss how understanding the collective, uncertain, and persistent nature of innovation changes the types of policy questions that should be addressed, if we want to achieve smart innovation-led growth.

Modern capitalism faces a number of societal challenges (e.g., climate change, youth unemployment, obesity, aging, rising inequality). These challenges have created a new agenda for innovation and growth policy that requires policy makers to “think big” about what kinds of technologies and socioeconomic policies are needed to fulfill visionary ambitions to make growth more smart, inclusive, and sustainable (e.g., the “Europe 2020” strategy; European Commission 2010). Such challenges are not strictly technological; they also require behavioral and systemic changes. To address them, lessons can be drawn from “mission-oriented” feats (Foray et al. 2012) that led to putting a man on the moon, or to the emergence of new technologies (e.g., the Internet, biotechnology, nanotechnology). Achieving such missions required companies that were willing and able to invest in long-term projects as well as a confident, willing “entrepreneurial state” that was able to take on the early, capital-intensive high-risk areas, which the private sector tends to fear (Mazzucato 2013a). A state is entrepreneurial when it is able and willing to invest in areas of extreme uncertainty, courageously envisioning the *direction* of change across public agencies and departments. An entrepreneurial state must welcome, rather than fear, the high risk and uncertainty across the entire innovation chain (from basic research to commercialization) and the experimentation processes required for organizational learning along the way (Hirschman 1967; Rodrik 2013). Most importantly, an entrepreneurial state must “think big” (Mazzucato 2013a).

In today’s world, it is becoming increasingly difficult for states to think big. We live in an era in which the role of government is limited to simply “facilitating” and “de-risking” the private sector and fixing market failures, rather than having a direct role in creating and shaping markets, and determining the direction of change, with the adequate budgets and governmental structures to do so. Indeed, when government agencies step out of this “facilitating” role, they immediately get accused of “crowding out” or “picking winners.”

The difficulties that governments have in thinking big stem from various forces. Since the 1970s, the idea of government as simple “regulator” and “administrator” has become prevalent, commensurate with attempts to downsize the state (Judt 2011). Since the global financial crisis, the emphasis on cutting *public* debt, even though *private* debt caused the crisis, has inevitably affected the budgets of the very state agencies responsible for creating the horizontal and vertical types of investments needed to catalyze the technological revolutions of the past. In the United States, “sequestration” has put close to one-third of the U.S. public R&D budget (\$130 billion per year) at risk (LaMonica 2013). In Europe, the “fiscal compact” (which requires member states to have fiscal deficits that are only 3% of their GDP) is putting pressure on countries to cut spending on areas like education and R&D. Spain, a critical case, has cut publicly funded R&D by 40% since 2009 (Buck 2013). In the United Kingdom, while the government has “ring-fenced” the science budget, in real (inflation-adjusted) terms, this has resulted in a 15% cut (Weir 2014). Meanwhile, the opposite trend is occurring in countries that continue to grow. Germany has increased its education, research, and science budget by the same amount (€10 billion per year) since 2009, raising it to almost 10% of its GDP (Federal Ministry of Education and Research 2013); while China has made increases in this area of 170% over the last five years.

Nevertheless, finding a way for government to think big involves more than just throwing public money at different activities. It requires a new economic framework that can justify the role of the public sector in “directing” change, forming the right institutional structures that can foster and adapt to change in a dynamic way. It requires a framework that justifies the catalytic role of government and its ability to transform landscapes, so that it can create and shape markets, not just fix them. It requires new indicators with which to evaluate public investments, capturing the “transformational” catalytic impact that Keynes (1926) suggested should be the objective (“doing those things which at present are not done at all”). It requires different insights on the organization of government as well as on the distribution of risks and rewards that emerge from the collective and systemic effort toward “smart” innovation-led growth.

Beyond Market Failures

The road to the free market was opened and kept open by an enormous increase in continuous, centrally organized and controlled interventionism. —Karl Polanyi (1944/2001:140)

Market failure theory justifies public intervention in the economy only if it is geared toward fixing situations in which markets fail to allocate resources efficiently (Arrow 1951). The market failure approach suggests that governments intervene to “fix” markets by investing in areas with “public goods” characteristics (e.g., basic research or drugs with little market potential) and by

devising market mechanisms to internalize external costs (e.g., pollution) or external benefits (e.g., herd immunity). Figure 14.1 illustrates five key sources of market failures (i.e., factors or behaviors that result in costs or benefits not reflected in the price system).

Within the mainstream framework, market failure is a *necessary but insufficient* condition for governmental intervention (Wolf 1988). The sufficiency results from an assessment that the gains from the intervention outweigh the associated costs due to “governmental failures” (Tullock et al. 2002): capture by private interests (nepotism, cronyism, corruption, rent seeking; Krueger 1974), misallocation of resources (e.g., “picking losers”; Falck et al. 2011), or undue competition with private initiatives (“crowding out”; Friedman 1979). Thus, there is a trade-off between two inefficient outcomes: one is generated by free markets (market failure), the other by governmental intervention (government failure). The solutions advocated by neo-Keynesians focus on correcting failures such as imperfect information (Stiglitz and Weiss 1981). Solutions advocated by public choice scholars (Buchanan 2003) focus on leaving resource allocation to markets, which may be able to correct their failures on their own.

While market failure theory provides interesting insights, it is at best useful to describe a *steady-state* scenario in which public policy aims to put patches on existing trajectories provided by markets. It is less useful when policy is needed to create and shape new markets dynamically (i.e., “transformation”). This means that it is problematic for addressing innovation and societal challenges, because it cannot explain the kinds of transformative, catalytic, mission-oriented public investments made in the past that created new technologies and sectors which had previously not existed (e.g., the Internet, nanotechnology, biotechnology, clean technology), and which the private sector feared. Such mission-oriented investments coordinated public and private initiatives, built new networks, drove the entire techno-economic process, and, in turn, created new markets.

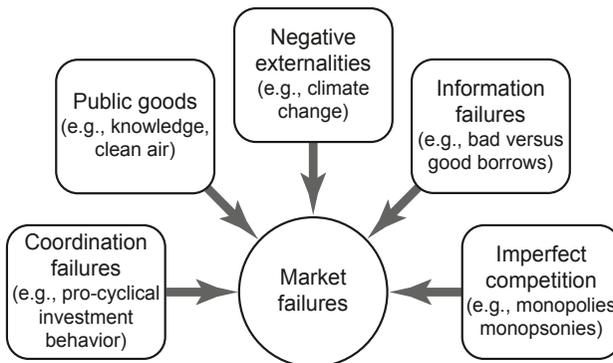


Figure 14.1 Sources of market failures, based on a typology of market failures (Mazzucato and Penna 2014).

Market failure theory, which continues to guide policy making today, is limited by the inability of the state (a) to set the direction of change; (b) to form indicators through which to evaluate its transformational impact; (c) to set up organizations in the public sector willing and able to welcome, rather than fear, failure; and (d) to earn some return to fund the many inevitable failures that are integral to the process of innovation.

Directionality: Envisioning and “Picking” Strategically

Policies which aim to correct markets assume that once the sources of failure have been addressed, market forces will efficiently direct the economy toward a path of growth and development. Markets, however, are “blind” (Nelson and Winter 1982; Dosi 1982), and the direction of change provided by markets often represents suboptimal outcomes from a societal point of view. This is why, in addressing *societal challenges*, states have had to lead the process to provide the direction toward new “techno-economic paradigms” (Perez 2002), which do not spontaneously emerge from market forces. In the mass production revolution and the information technology (IT) revolution, governments made direct mission-oriented investments in requisite technologies which enabled these revolutions to emerge; they also formulated bold policies to allow full deployment throughout the economy (Mowery 2010; Block and Keller 2011). For instance, every technology that makes the iPhone “smart” (e.g., the Internet, GPS, touch-screen display, SIRI; see Figure 14.2) is the direct result of public funding (Mazzucato 2013a). Even the general-purpose technologies (from electricity to IT) used were an outcome of public policy (Perez 2002). Furthermore, in the IT revolution and in the emerging clean-tech revolution, government has funded not only the actual technologies (e.g., mainframes, the

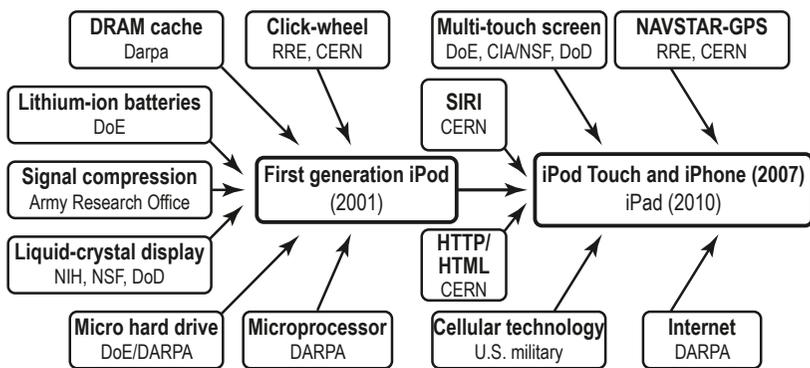


Figure 14.2 State investments funded all of the key technologies behind the iPhone (Mazzucato 2013a).

From “Complexity and Evolution: Toward a New Synthesis for Economics,” David S. Wilson and Alan Kirman, eds. 2016. Strüngmann Forum Reports, vol. 19, series ed. J. Lupp. Cambridge, MA: MIT Press. ISBN 978-0-262-03538-5.

Internet, wind and solar power, fuel cells), it has also created a network of decentralized public and private actors (a “developmental network state”; Block and Keller 2011) and provided early-stage funding to companies, when risk-averse private finance would not, and devised special tax credits that favored some activities over others (Mazzucato 2013a, b). This points to a different analytical problem facing policy makers: The issue is not whether to intervene or stand back, but rather to understand how particular directions and routes should be chosen, and then to determine how activities should be mobilized and managed to meet the dynamic social and technological challenges.

Evaluation: Static Versus Dynamic Metrics

Market failure theory has developed concrete indicators and methods to evaluate government investments. These stem from the framework itself, usually through a cost-benefit analysis that estimates whether the benefits of public intervention offset costs associated with both market failure and policy implementation (including “governmental failures”). There is, however, a mismatch between the intrinsically dynamic character of economic development and the static tools used to evaluate policy. Diagnostic tools and evaluation that are based on market failure theory involves identifying the sources of market failure and targeting policy interventions to correct them. This entails *ex ante* considerations about administrative and fiscal requirements and the political-economic consequences of intervention. Such an exercise usually consists of the following steps:

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

To evaluate public policies and investments that aim to address societal challenges, this is a limited toolbox, because it statically evaluates an intrinsically dynamic process. By not allowing for the possibility that government can transform and create new landscapes that did not previously exist, the ability to measure such impact is affected; economists often resort to an analysis of the public sector as an inefficient private one (Mazzucato 2013a). This is evident not only in the area of innovation, but also for public services. Accusations

follow of government crowding out businesses, which implies that those areas which government moves into could have been areas for business investment. Such accusations are at best defended through a “crowding in” argument, which rests on showing how government investments create a larger pie of national output that can be shared (the savings) between private and public investors. Such defense, however, does not capture the fact that the goal of public investments is not merely to “kick start” the economy, but rather to define directions that “*do those things which at present are not done at all*” (Keynes 1926, part 4). By not having *indicators* for transformative action, the toolbox affects the government’s ability to know when it is simply operating in existing spaces or making novel things happen that would not have happened anyway (its “additionality”). This often leads to investments that are too narrow or directed within the confines of the boundaries set by business practices of the prevailing techno-economic paradigm (Abraham 2010).

Organization: Learning, Experimentation, and Self-Discovery

If brought to its extreme, as advocated by critics from public choice, market failure theory calls for the state to intervene as little as possible in the economy and in a way that minimizes the risk of “government failure” (e.g., crowding out, cronyism, corruption). This view requires a structure that insulates the public sector from the private sector (to avoid issues such as agency capture) and has resulted in a trend of “outsourcing” that often rids government of the knowledge capacities and capabilities (e.g., around IT) necessary for managing change. Studies have examined the influence of outsourcing on the ability of public institutions to attract top-level talent with the relevant knowledge and skills to manage transformative mission-oriented policies (Kakabadse and Kakabadse 2002). Without such talent and expertise, it will be difficult for the state to coordinate and provide direction to private actors when formulating and implementing policies that address societal challenges. Indeed, a self-fulfilling prophecy seems to be at work: the less “big thinking” occurs in government, the less talent/expertise the public sector is able to attract, the less well it performs, the less “big thinking” it is allowed to do. To promote transformation of the economy, by shaping and creating technologies, sectors, and markets, the state must organize itself so that it has the “intelligence” (policy capacity) to think big and formulate bold policies. This does not mean that it will always succeed. Indeed the underlying uncertainty in the innovation process means that the state will often fail (Nelson and Winter 1982; Hirschman 1967). However, if the emphasis is on the process of policy making (Rodrik 2013) that will allow the public sector to envision and manage transformational change, then understanding the appropriate structures of public organizations and their “absorptive capacity” (Cohen and Levinthal 1990) is essential.

Risks and Rewards: Toward Symbiotic Private–Public Partnerships

Market failure theory says little about cases in which the state is the *lead investor and risk taker* in capitalist economies through mission-oriented investments and policies (Foray et al. 2012). Having a vision of which way to drive an economy requires direct and indirect investment in particular areas, not just “creating the conditions” for change. Crucial choices must be made, the fruits of which will create some winners but also many losers. Figure 14.3 shows how much public money has been spent on early-stage seed financing through the U.S. Small Business Innovation Research (SBIR) program. This funding has become increasingly important, especially in light of the fact that venture capital aims to exit within three years, whereas innovation takes 15–20 years. The SBIR program also guaranteed loans for innovative high-risk projects. For example, the Obama administration has provided a direct \$500 million loan to two green-tech companies: Solyndra and Tesla Motors. While the latter is often glorified as a success story, the former failed miserably and became the latest example, used widely by both economists and the more popular treatment in the media, of government being unable to pick winners. Indeed, the taxpayer picked up the bill (Wood 2012), and complained. This demonstrates the need to build a theoretical framework that can help the public sector understand its “portfolio” choices (Rodrik 2013, 2015) and how to socialize not only the risks of those investments but also the rewards (Lazonick and Mazzucato 2013; Mazzucato 2013a). Should the taxpayer shoulder losses, such as with Solyndra, but exact no returns, such as from Tesla profits (Mazzucato 2015b)? The question comes down to whether, in a market failure theory framework, the government deserves to retain a direct share of the profits generated from the

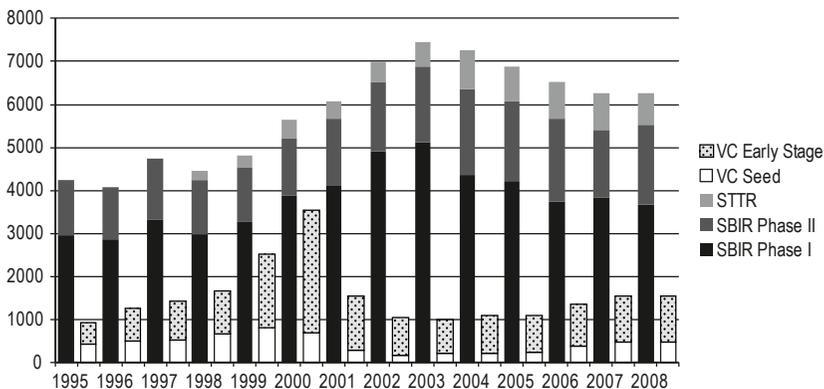


Figure 14.3 Early-stage and seed-funding awards for small business innovation research (SBIR) and venture capital (VC). After Keller and Block (2012).

growth it fosters. Put another way, are taxes currently bringing back enough return to government budgets to fund high-risk investments which will probably fail? It is well known that companies which benefit greatly from government investments have been successful in avoiding taxation: Google, whose algorithm was funded by the U.S. National Science Foundation, has been criticized for this, as have Apple, Amazon, and a host of “new economy” companies. Even if such companies were not dodging taxation, tax *rates*, such as on capital gains, have been falling due to the narrative that it is a narrow set of agents who are the “real” innovators and risk takers.¹

Socializing Both Risks *and* Rewards

Instead of asking: what benefits [has] this project yielded, it would almost be more pertinent to ask: how many conflicts has it brought in its wake? How many crises has it occasioned and passed through? And these conflicts and crises should appear both on the benefit and the cost side, or sometimes on one—sometimes on the other, depending on the outcome (which cannot be known with precision for a long time, if ever). —Alfred O. Hirschman (in Adelman 2013:313)

Innovation is a highly *uncertain* process; it takes a very long time to develop new technologies, and success is not guaranteed. For every Tesla (i.e., companies that receive public funding, and become market darlings), there are many Solyndras (i.e., companies that receive public funding, and then go bankrupt). For every Internet (government-funded technologies with great success) there are many Concordes (government-funded projects that fail commercially). Indeed Solyndra’s bankruptcy has been used as an example of government failure, not recognizing that if government is to act like a venture capitalist, which it historically has, it will undergo many failures to reach some successes. What has not been thought through enough is how success or failure should be measured from a government’s standpoint, and how to make certain that (like private venture capital funds) the state can reap a return from the successes, to cover its losses and support the next round of investments: a revolving fund. This is especially important given the path-dependent and cumulative features of innovation. Returns emerge slowly: they are negative in the beginning and slowly build up before huge financial gains are realized (e.g., at the end of the biotech, dotcom, and nanotech revolutions). One can think of returns as a cumulative distribution curve (Figure 14.4). Unless we understand the collective process of innovation, we risk allowing a narrow group of actors to reap not just the returns proportional to their marginal contributions, but close to the entire *integral* under the curve.

¹ In the late 1970s, the National Venture Capital Association lobbied for capital gains tax to fall from 39.6% to 20% over a period of five years (Lazonick and Mazzucato 2013). Warren Buffett (2011) admitted that such tax changes did not affect investment, only inequality.

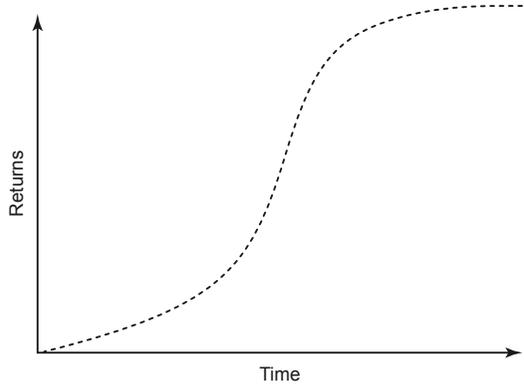


Figure 14.4 A cumulative distribution curve of returns.

So Who Gets What?

Economists argue that the state already receives an indirect return on its investments through taxation. However, the following arguments negate this reasoning:

1. Tax evasion (legal and illegal) is common and realistically will not disappear.
2. Taxes, such as capital gains, have been falling over past decades, precisely due to a false narrative about who the wealth creators actually are.
3. Global movements of capital mean that the particular country or region (e.g., the European Union) that funds an innovation might not reap the benefits in terms of local job creation.

While it is correct to think that investments in the “basics” (e.g., education, health, research) should not be thought of as earning a return, direct investments at companies and particular technologies pose a very different problem. If the state is asked to make such investments (which it undoubtedly has been and will continue to do, since financial markets have become even more speculative and short-termist), it is necessary for the state to cover its inevitable losses when they arise.

Where technological breakthroughs have occurred as a result of targeted state interventions for specific companies, there is potential for the state to reap some of the financial rewards over time, by retaining ownership of a small proportion of the intellectual property created. This is not to say that the state should have exclusive license or hold a large enough proportion of the value of an innovation to deter a wider spread of its application (and this has never been the case). The role of government is not to run commercial enterprises, but to spark innovation elsewhere. However, a government should explore whether it is possible to own some of the value it has created, which over time could generate significantly higher value and drive reinvestment into other

growth-generating areas. By adopting a “portfolio” approach to public investments in innovation, success from a few projects could help cover losses from other less successful projects (Rodrik 2015).

There are various ways to consider a direct return to the state for its investments in innovation. One is to ensure that loans and guarantees handed out by the state to business are not issued without strings attached. Loans and grants could have conditions, such as “income-contingent loans,” similar to that of student loans. If a company receives a loan or grant from the state, it should be required to pay back a portion if and when it makes profits above a certain threshold (Mazzucato 2013b). This is not a complicated concept, but it does run counter to some deep-seated assumptions. Currently, with budget deficits under so much pressure, it is no longer possible to ignore this issue.

Apart from income-contingent loans, the state could retain equity in the companies it supports. Indeed, this occurs in some countries: in Israel, through the Yozma public venture capital fund, and in Finland, where SITRA (one of Finland’s public funding agencies) retained equity in its early-stage investments in Nokia. Equity stakes are also retained by state investment banks, such as the Brazilian Development Bank (through *BNDESPar* or “BNDES Participations”), the China Development Bank, and the German development bank (*Kreditanstalt für Wiederaufbau*, KfW), which are two lead investors in the emerging green economy (Mazzucato and Penna 2014). However, state equity in private companies is often feared in countries like the United States and the United Kingdom (and other countries that have copied the Anglo-Saxon model), as this is perceived as a precursor to “communism”! Despite this fear, the most successful capitalist economies have had active states that have made risky investments that resulted in truly technological revolutions (Perez 2002). We have been too quick to criticize public investments when things go wrong (e.g., Concorde or Solyndra) and too slow to reward them when things go right (e.g., the Internet or Tesla).

New Indicators to Capture the Creation and Shaping of Markets

Practical men, who believe themselves to be quite exempt from any intellectual influence, are usually the slaves of some defunct economist....I am sure that the power of vested interests is vastly exaggerated compared with the gradual encroachment of ideas. —John M. Keynes (1936/1973:241)

The world is currently facing a conundrum. Too few places are active in innovation, and the few that are often get attacked for being too active: crowding out and picking winners.

Critics claim that public investments, active industrial policies, and other types of “governmental intervention” in the economy—while potentially justified in the case of market failures—usually lead to worse outcomes as a result of government failure. Indeed, the common criticisms about crowding out (Friedman

1979) or picking winners (Lisboa and Latif 2013)—two types of government failure—derive directly from the limited (mainstream) theoretical perspective about what small innovative businesses do (Mazzucato and Penna 2014).

The crowding-out criticism can take two forms. The first concerns public investment. On one hand, public investment would prevent the development of a long-term capital market because it would displace (crowd out) private initiative. Managed long-term interest rates would crowd out credit which would otherwise be supplied by private agents in a free market, thereby inhibiting both the activity of commercial banks and the creation of a capital market. On the other, public investments would diminish the amount of savings available for private investment or lead to changes in exchange rates, both of which would lead to lower level of private investments. In 2010, for instance, the KfW bank was accused of crowding out European sovereigns, supranationals and agencies issuing short-term debt (GlobalCapital 2011), because it issued large amounts of commercial papers. Theoretically, this facet of the crowding-out critique is associated with mainstream (neo-Keynesian or New Classical) growth models that result in public investments crowding out private investments, particularly if governmental deficits are financed through debt (Friedman 1979). However, the crowding-out hypothesis is a matter of empirical investigation more than theoretical, particularly if the state is doing precisely what the private sector is not.

A second common criticism attacks mission-oriented public investment which targets particular technologies and sectors in an attempt to pick winners. Critics argue that the state is poor at doing this because it lacks the capability, information, and incentives to make these attempts succeed (Hanson 2004). In this view, politicians and bureaucrats are bad or biased managers who lack the discipline provided by markets. This criticism, summarized in *The Economist* (August 5, 2010), concludes that “the present round of industrial policy will no doubt produce some modest successes—and a crop of whopping failures.” While the inability of the state to pick winners is often an *a priori* assumption of many analysts, very few studies have systematically evaluated attempts by the state to pick winners, from the Concorde to Airbus (Mazzucato and Penna 2014).

Such criticisms are misplaced because they ignore both the essence of mission-oriented public investments and empirical evidence. Because they are derived from particular theories and models, it is necessary to develop a new theoretical framework that is capable of explaining and properly evaluating the transformative character of mission-oriented investments. Such criticisms also ignore an uncomfortable fact: the increasing financialization of the real economy, in which private finance funds private finance (adding to the percentage of added value comprised of financial intermediation) as well as private companies sometimes spend more on gimmicks (e.g., share buybacks) than on value-creation activities such as R&D (Lazonick and Mazzucato 2013).

A new framework would bring about novel types of questions and criticisms. The point is not to defend the state and its public investments or activities per

se but rather to make certain that the criticisms directed toward the state are not blind to dynamic transformative processes and outcomes, because they stem from a limited framework like market failure theory. This requires a new set of diagnostic and evaluation practices, with novel indicators that are able to capture the transformative dynamics of mission-oriented policies. Otherwise we have a self-fulfilling prophecy, whereby a limited framework automatically judges anything that steps outside its domain as negative. For example, working with a portfolio means having both high-risk investments (of which most will fail) and low-risk investments (of which most will be steady earners). The latter might include support for more traditional firms and technologies, which for whatever reason may need continued support in competitive markets. It is interesting to note that the state is often blamed for both: it should not be funding incumbents and should not be risking taxpayer money on high-risk areas. This can lead to a paralysis of doing nothing. It has led to a paralysis in the risk–reward relationship, whereby failure to see government as the lead risk taker and investor has made government too cautious to act upon its rights (as agreed in the 1980 Bayh-Dole Act) to cap prices on drugs that are publicly funded or to exercise its option to buy shares of companies to which the state provides early-stage, high-risk guaranteed loans. This is clearly seen, for example, in the Tesla case, when the U.S. government had the option, but decided not to use it, to buy 3 million shares when the share price was only \$8, compared to the \$93 when the loan was paid back; currently, Tesla’s shares fluctuate above \$200.

Conclusion: A New Framework Requires New Questions

Solutions derived from market failure theory (e.g., downsizing the state apparatus, promoting market-based mechanisms to counter market failures, insulating public agencies from the private sector) might hold for steady-state situations, but not for situations in which public policy is required for *transformation*, such as those witnessed through the technological and socioeconomic missions of the past. Such missions were not aimed at fixing market failures or *minimizing government failures* but rather on *maximizing the transformative impact of policy to shape and create markets*.

Addressing the need for government policy to “transform,” be catalytic, create and shape markets not only fixes them, it helps redirect key questions for economic policy from static ones which worry about crowding out and picking winners to more dynamic ones that are constructive in forming the types of public–private interactions that will spur new innovation and industrial landscapes. Government needs not only to pick different technologies or sectors but to ask what it wants from those sectors. Just as putting a man on the moon required many sectors to interact, the “green” direction being debated today requires all sectors to change. Green is not only about wind, solar, and

biofuels; it also concerns new engines, new maintenance systems, the insulation of buildings, and novel ways of thinking about product obsolescence (Mazzucato and Perez 2015). This requires not only the prescription for specific technologies, but the intended directions for change, which then bottom-up solutions can strive to achieve. As Stirling stated in the 2014 Annual Report of the Government Chief Scientific Adviser:

The more demanding the innovation challenges like poverty, ill health or environmental damage, the greater becomes the importance of effective policy. This is not a question of “picking winners”—an uncertainty-shrouded dilemma which is anyhow equally shared between public, private and third sectors. Instead, it is about engaging widely across society, in order to build the most fruitful conditions for deciding what “winning” even means.

Government would benefit from adopting a portfolio approach to public investments in innovations, nurturing the explorative, plural, and trial and error aspect of change. This requires thinking about technological change in novel ways as well as structuring future public agencies with creative, adaptive, and explorative capacity.

To approach the innovation challenge of the future, we must open up the discussion, move away from “picking winners” and “crowding out,” and engage in discourse on four key areas:

1. Directions: How can public policy be understood in terms of setting the direction and route of change? What can be learned from the ways in which directions were set in the past, and how can we stimulate more democratic debate about such directionality?
2. Evaluation: How can an alternative conceptualization of the role of the public sector in the economy translate into new indicators and assessment tools for evaluating public policies, beyond the microeconomic cost-benefit analysis? How does this alter the crowding-out narrative?
3. Organizational change: How should public organizations be structured so that they accommodate risk taking and exploration, and the capabilities needed to envision and manage contemporary challenges?
4. Risks and rewards: How can this alternative conceptualization be put into practice so that investment tools can socialize risk and rewards, thus enabling “smart growth” to be “inclusive growth”?

Acknowledgment

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