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The green transition: public policy, finance and the role of the State

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THE GREEN TRANSITION:

PUBLIC POLICY, FINANCE AND THE ROLE OF THE STATE*

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Abstract

While investments into renewable energy technologies are growing almost everywhere, the chances to meet ambitious emission and climate targets, as those envisaged in the Paris Agreement, are scant. To speed up the transition, policy makers need to design and implement a policy mix that could affect not just the quantity of green finance, but its quality as well. In this paper, we argue that a mission-oriented approach to the transition from an economy with high, to one with low greenhouse gas emissions, coupled with the state taking on the role of an entrepreneurial state, could provide an effective win-win strategy to address climate change concerns (embodied in emissions reduction and adaptation boosting) and build the basis for the next phase of growth and technological progress. In practice, this amounts to (i) abandoning the view that cost-internalization of environmental externalities would suffice to induce an effective transition (ii) developing a multi-level and cross-sectoral governance of the transition, with a clear direction in terms of the technological trajectory to favour, and (iii) designing a policy mix encompassing: fiscal instruments, targets and standards; public-private co-funding schemes; financial regulation; and disclosure practices. Social scientists should support such ambitious policy-design processes through adequate model development, where a combination of policies, and a directive role of the state, can be accommodated and examined in detail.

Keywords: market-shaping; mission-oriented; green finance; renewable energies; transition; entrepreneurial state.
JEL: H11; H70; Q48; Q54; Q55.

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"Make no mistake: a new world order is emerging. The race for leadership has already begun. For the winners, the rewards are clear: Innovation and investment in clean energy technology will stimulate green growth; it will create jobs; it will bring greater energy independence and national security."
Josef Ackermann (2010) [†]

1. Introduction

A decade after the last financial crisis hit the European Union, signs of recovery are still weak and uneven. Under business-as-usual practices, regional disparities in Europe are likely to increase and unemployment will not fall (Semieniuk et al., 2011; Iammarino et al., 2018). However, the European Union can revitalize its economy by developing a credible vision for investmentled growth, where the direction of growth is just as important as the rate of growth. Fully embracing such a perspective, we consider the challenge of building a low-carbon economy both as an independent objective and as an opportunity to create "good" green growth.

Climate change is one of the most significant challenges humankind has ever faced. Fostering growth while reducing emissions requires a transition towards low carbon energy technologies and, more extensively, it requires greening our economic system. A green economy should not be limited to the creation of some niche sectors concerned with environmental protection. It is an economy with very low levels of carbon emissions in the atmosphere, and it protects biodiversity and environmental quality. It delivers high levels of human welfare (not only measured in monetary terms) for low throughput of energy and material resources. Fundamentally, it requires changes to production, distribution and consumption patterns, and innovation strategies that strive to eventually lower the material content of all sectors.

Moving towards such goals requires ambitious and timely policies on both the supply and demand sides, creating the conditions for the transition to happen and, further, generating "good" green growth and jobs (Perez and Murray-Leach, 2018). In conjunction with the selection of correct policy tools, a key question concerns how to finance the turn from fossil fuel based (brown) to renewable energy (green) technologies.

At the UNFCCC COP21 conference that took place in Paris in 2015, the majority of UN member states signed the Paris Agreement, aimed at limiting global temperature increase below 2°C on pre-industrial levels (UNFCCC 2016), while global temperature had already increased by 1°C on pre-industrial levels (Wuebbles et al. 2017). Limiting global temperature increase to 2°C, or below, would require keeping Greenhouse Gases (GHG) emissions concentration in the atmosphere at a level close to 450 parts per million (ppm) by 2050 (IPCC 2018; Rogelj et al. 2015). This, in turn, implies an urgent transition to sustainable, carbon-neutral production and consumption patterns, and the

[†] Green Growth - the Role of Financial Institutions. Global Metro Summit: Delivering the next Economy, Chicago, 8 December 2010

phasing-out of carbon-intense investments. Article 2, para 1(c) of the Paris Agreement explicitly defines the goal of **"[**M]aking finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development."

A fast mobilization of capital in low-carbon sectors, in particular in the production and use of renewable energy, is fundamental to promoting sustainable infrastructure development for the nearly 10 billion (bn) people that are likely to populate the planet by 2050 (UN 2019). It has been estimated that additional investments required in the energy sector are between $ 1-2.5 trillion (tn) dollars per year by 2035 at the global level (IEA 2017; IPCC 2018), and Eur 180 bn per year in the European Union (EU) alone, between 2021 and 2030 (HLEG 2017). However, investments are not flowing at the pace and amount needed (CPI 2017). This risks locking the global and European economies and financial systems into carbon-intense assets, that are at risk of losing financial value due to the combination of climate change and future policy stringency, creating so-called carbon 'stranded assets' (Leaton 2012).

In this paper we discuss the challenges related to green energy financing (Section 2) and review the policy trade-offs and the role of government spending in fostering funding of low carbon technologies (Section 3). We provide a series of policy-relevant insights (Section 4) and, finally, we conclude the paper by exploring and recommending the role of mission-oriented innovation approaches for the green transition (Section 5).

2. **Financing green energy: who, when, what**

One of the major challenges that the COP21 Paris Agreement of December 2015 poses to our societies consists of finding effective measures to decouple global economic growth from fossil fuel technologies. As with any technological transformation, a shift to renewable energy requires an appropriate investment landscape.

Historical economic and investment discussions of climate change, which frame it as a 'market failure', have led governments and businesses to see themselves in opposition in a zero-sum game. Policy makers are not invited to take investment or policy risks, but rather to 'fix' the problems of the market, ie. to level the playing field, and then get out of the way. Instead of taking just this market-fixing approach, policy should actively co-create markets, tilting the playing field in a green direction. In practice this means that policies which are focused on market-fixing, such as carbon taxes, are a step in the right direction, but will not, alone, get us to a green transition. To avoid innovation continuing its route of lock-in to a high-carbon path, and to actively turn our backs on stagnant innovation landscapes, policy must ensure that investments into low-carbon innovation are rewarded (Mazzucato and Perez, 2015).

Moving to a greener low carbon economy means re-directing all sectors and all actors—public, private and civil society—towards economic growth in a sustainable and inclusive direction. Markets should be outcomes from this co-created, cohesive action. Planning for this shift must acknowledge the complexity inherent in re-orienting a global economic and biophysical system. For a systemic and systematic shift towards a green economy, policy cannot limit itself to particular parts of the innovation chain. Instead, companies and developers in green sectors must be able to grow with the confidence that their work will continue to be funded both upstream and downstream, from basic research to increase scientific and technological knowledge, through to applied research into real-

world problems. The latter often require particular institutional structures, such as the Fraunhofer Institutes in Germany or the Catapults in the UK (Mazzucato and McPherson, 2018). Supply and demand side policy levers must be pulled in tandem, with public procurement on the demand side, for example enacting low-carbon materials policy and deploying this in large-scale government-led construction or manufacturing projects; whilst activity such as network development, information dissemination and mission-planning take place on the supply side.

A market-shaping, green-oriented approach should be adopted for green innovation policy and industrial strategy; markets will not find the desired direction on their own. A mission-oriented approach is one lens which can be adopted to set a clear, long-term direction for change. The market-shaping role of missions has been extensively explored by Mazzucato (2016; 2018a,b). A systemic market-shaping approach must guide financing (both public sector and its impact on private sector investment – see below), structural economic shifts, and the policy mix needed to get there, as explored in greater detail over the course of this paper.

Not all green technologies – technologies that would help construct a climate resilient economy - are alike. They vary substantially in terms of their current state of development, novelty and riskiness. While some have been successfully employed for at least a couple of decades (e.g. onshore wind for electricity generation), others are still embryonic (e.g. energy storage or direct air capture), with the potential for future development largely unknown, especially with respect to the technological opportunities they might create. Here we focus with a generic and aggregate perspective on techniques to manage energy supply and demand sides. While it is clear that different technologies require different types of finance and investments, such an analysis is beyond the scope of the present work.

The question of how to finance a green transition is wide open. Too often, the debate focusses on the *quantity* of finance and not on its *quality*. The focus is on scaling up finance to invest into a low carbon energy transition, disregarding the fact that there are different types of finance which have different impacts for this transition. While it is typically acknowledged that public sources of finance are important to finance the initial research stage, there is less attention to mid-stream development (except with Venture Capital (VC) - but *who* invests in the VC funds is frequently left unanswered), and downstream deployment finance. This is in spite of recognition of a financing gap (or “valley of death”), that requires large investments to develop product competitiveness, and is thus capital-intensive and high risk. If all finance is treated the same, the policy debate boils down to a discussion about policies to “de-risk” investments in general.

A different perspective comes from viewing investors as a heterogenous group, and in particular recognizing that historically, the state has played a pre-eminent role in providing the high-risk, long-run investments needed for transformational innovation. Such ‘entrepreneurial states’ have taken on the lead role by staking out a vision for *where* to innovate, that is by setting a direction, and then acting as the investor of first resort to high-risk projects, not only at basic research level but throughout the innovation landscape: deploying a demonstration power plant is also very risky, but it is far more capital intensive than basic research (Mazzucato 2013, Mazzuato and Semieniuk 2017). These activities are carried out by a variety of public innovation institutions, wedded to a mission for innovation outcomes, which acts to stimulate the private sector to actively participate and invest. This perspective suggests that rather than ‘de-risking’, ensuring high and appropriate quality of direct

finance deployed by public actors is crucial in transitioning to a green economy (Mazzucato 2015, Mazzucato, Semieniuk et al. 2018).

Using this green entrepreneurial state lens, Mazzucato and Semieniuk (2017; 2018), Semieniuk and Mazzucato (2018) and Mazzucato, Semieniuk and Watson (2015) closely inspect the quality of finance and its impact on investments in the renewable energy sector from a global perspective. In presence of rapid growth in renewable energy spending over the last 15 years (Figure 1, top panel), they find that different financial actors (e.g. commercial banks, state banks, energy companies, state-owned and private utilities) were active in different technological areas. Crucially, the presence of these types of investors was deeply intertwined with the relative riskiness of the technology being financed. In particular, various state-owned enterprises and government agencies invested a much larger share of their funds in high risk sectors than any privately-owned actors. This tendency is also visible in Research & Development (R&D) funding, where the share of government R&D funding is higher in technologies farther away from commercialization, such as tidal and wave energy, while private sources predominantly fund R&D in more established technologies, such as wind energy (Semieniuk and Mazzucato, 2018). Hence, the quality of available finance matters, as it influences the quantity of funding devoted to high-risk, high-reward projects in the renewable energy sector and ultimately the direction of innovation.

[FIGURE 1 ABOUT HERE]

Additionally, public finance can be crucial not just in fuelling research, but across the innovation landscape, where the various areas and amounts of total renewable energy finance destinations are shown in Figure 1 (b). Thus, public sources of finance played a crucial role in midstream product development financing via various "public Venture Capital" agencies, that often provided more money than private venture capital, combined with substantial grant funding (Mazzucato and Semieniuk 2017).

At the level of deployment and diffusion, publicly controlled sources raised up to 40% of total financial sources for renewable energy asset finance in 2014 (Mazzucato and Semieniuk 2018). Indirect instruments that commit public funds, such as loan guarantees and export credit guarantees, additionally alter the quality of finance and increase projects' access rate to streams of private financing.[‡] These direct and indirect funds are further supplemented with due diligence, signalling the creation of trust by public banks (Geddes, Schmidt and Steffen 2018). These results conflict with the idea of the private sector taking over low-cost and low-risk investments, and the idea that fighting climate change can be achieved while reducing public sector activity, but support the entrepreneurial state perspective (Mazzucato, 2013).

Finally, private actors were more likely to be active in high risk areas when public sector actors were already co-investing on the same project, supporting the idea of public finance sources dynamizing private ones. This is an example of market-shaping activity which is under-acknowledged in both renewables and other innovative sectors. As can be seen in Figure 2, public actors provide a high

[‡] For example, as reported by Mendelsohn and Kreycik (2012), a surge in photo-voltaic panels installations in 2011 in the US was mainly driven by public grants and private loans underwritten by public loan guarantees, as the risk was too high for other types of financing schemes.

share of risk finance with a strong reduction of the relative risk exposure borne by private investors. Moreover, within high risk co-financed projects, the share of money from the public investors exceeded 40% of a project's total investment value on average (see Figure 2 inset).§ Moreover, the public banks engaged in large high-risk co-investments often offered concessionary interest rates or subordinated debt, thereby getting lower returns and making the project more attractive to private investors (Steffen and Schmidt 2018, Mazzucato, Semieniuk et al. 2018). In Figure 3 we see a concrete example where public is leading in new high-risk areas (marine).

[FIGURE 2 ABOUT HERE]

[FIGURE 3 ABOUT HERE]

Direct public finance of course does not replace but complements procurement policies geared towards creating a market for renewable energy (Mazzucato, Semieniuk and Watson 2015) as well as fiscal measures such as feed-in tariffs (Deleidi, Mazzucato and Semieniuk, 2019). Overall, the last two decades have seen an increasingly central role for publicly-owned actors in leading and fostering investments into renewable energy projects – across the whole innovation and financing chain - that will contribute to a green transition. Given both the size of such investments and their catalytic role (Mazzucato and Semieniuk 2017), the leadership of governments is central to moving away from fossil fuel technologies.

3. Structural Shifts to Low Carbon Energy and a Systemic Policy Mix

As discussed in the previous section, public finance and procurements have a key role in supporting the transition to renewable energy. More generally, the challenge of sustaining a timely green transition needs EU governments cooperating and implementing an effective set of policies. As emphasized in Mazzucato (2018a), a mission-oriented approach is useful to guide innovation as well as the evolution of key, selected technological solutions. Although "missions" are set from above, they inspire bottom up experimentation across a diversity of sectors (Mazzucato, 2018b, Mazzucato, 2019). Successful missions should result in a clear target which rewards those organizations 'willing' to engage, whereby the priorities are translated into concrete policy instruments and actions to be carried out by all levels of the public institutions involved. They should not be targeted at a specific sector, but rather a problem and bring in sectors and actors as required, from international public sector actors through to city and town governments, civil society, activists, and the third sector (Mazzucato and McPherson, 2018)

Given the current shares of low carbon energies in the EU (see Figure 4), a fully-fledged low carbon transition remains some years away. By being at the forefront of technological development in the field, the EU can take advantage of the opportunities offered by renewable energies and climate change management.

§ Similarly, Nemet et al. (2018) document that among hundreds of demonstration projects in clean technologies in the last 75 years, public sources financed a median 64% of investments.

[FIGURE 4 ABOUT HERE]

For example, a recent study published in Nature Sustainability by Thacker et al. (2019) finds that the achievement of the UN's Sustainable Development Goals (SDGs) can be substantively influenced – both directly and indirectly – by investments in certain types of infrastructure. In particular, the water and energy infrastructure sectors exhibit the largest direct influence on individual SDGs number 6 (clean water and sanitation) and 7 (affordable and clean energy) respectively, in a manner which is inherently reliant on cross-sectoral investment and mission-oriented approaches, discussed for the SDGs in Miedzinski, Mazzucato and Ekins (2018). There are good reasons to believe that embracing a mission-oriented approach could result in a win-win solution to green the energy sector. Infrastructure systems – including those in the energy sector - are desirable by society, but would be underproduced in a free market, thus requiring some form of public intervention to provide the investment and time necessary to deliver the final service. They could also induce and spur technological development in a green direction. Thacker et al. (2019) find that, while synergies exist across all major infrastructure sectors, the decarbonization of the energy system would have the largest implications for all other sectors (e.g. water, digital communications) and, particularly, for various transport infrastructures, which present opportunities for the synergistic use of electric vehicles and renewable energy.The 'system-of-systems' nature of infrastructure – where different sectors need to act in concert to deliver sustainable services (Hall et al. 2016) – provides support to the idea of an entrepreneurial state guided by a mission-oriented approach, and also illustrates that focussing on individual sectors might overlook important synergies. Furthermore, as badly planned infrastructure can have harmful and long-lasting impacts on both society and the environment, a programmatic approach involving public institutions across all levels of governance would be advisable, to maximize the chances of correctly recognizing the synergies between infrastructure sectors and to manage potentially harmful interdependencies (Thacker et al. 2019).

The case for a mission-oriented approach is further reinforced by recent evidence that macroeconomic conditions - the level of interest rates is a particularly notable example – can play a significant role in easing or hampering the financing conditions of renewable energies, thereby diverting the effect and size of monetary-based incentives. Egli et al. (2018) have used German data to show that the current literature might be overestimating the role of technological learning, and that increases in interest rates – typically associated with expansionary periods - may raise the costs of renewable electricity, where capital costs that are sensitive to the interest rate are a much bigger share of total costs than in fossil fuels, thereby making long term policy support a crucial factor in supporting the transition. Egli and co-authors also report that learning in the financial industry – while requiring time - is responsible for a sizable share (up to 24% in the case of wind technologies) of the observed reductions in the levelized cost of electricity from renewable sources. As emphasized in Mazzucato (2013, Mazzucato and Macfarlane, 2017, 2019), patient capital is exactly one of the distinctive features that a mission-oriented approach to the green transition would bring about.

The opportunities to engage in such a mission are large, especially in the EU, yet require coordination at all levels. Steffen and Schmidt (2019) have analysed the involvement of major multilateral development banks (MDBs) in energy-related projects, not just renewable, but from all sources. Their results show that the share of renewable energy projects has increased in the last decade, but considerable differences exist in terms of lending towards public and private initiatives.

While there is a marked tendency across development banks to prefer private renewable energy projects, carbon intensive initiatives still dominate the portfolio of public sector loans. For example, just 26% of the public projects financed by the World Bank concern non-hydro renewables, while more than 40% of projects concern fossil fuels. The picture is similar for European institutions: the European Investment Bank has provided funding to one public non-hydro renewable energy project for every three financed in the last 10 years, and the ratio moves to one in 20 for the European Bank for Reconstruction and Development.

One of the major reasons behind such tendencies is a lack of system-wide agreement on policy priorities. Following Steffen and Schmidt (2019), in public-sector organizations, country strategies and projects are agreed on between the finance-providing bank, and national governments; whereas, for power-generation projects, the MDBs have to meet the investment priorities of local authorities, and accommodate their 'level of comfort' with new technologies. Local governments are often more comfortable with fossil fuel power plants. A strong coordination across all levels of the state – brought together with a clear mission - would help manage such disparity, thus reinforcing the chances of a transition towards patient financing of low carbon technologies. Additionally, an increase in favourable, public support for the green transition (in terms of business environment and technological complementarity, for example) might decrease private sector uncertainty about green energy investments, thereby mobilising more private funds (see also previous section). An additional advantage stemming from greening banks' portfolios (including both private and public banks) is a reduction of the climate-related financial risk exposure of the banks (Monasterolo et al. 2018; Lamperti et al. 2019b,c). As a consequence, climate policymakers might consider further extending banks' financing capabilities in the energy sector, conditional on a relative increase of renewables' share – for example, through an increase of paid-in capital or, alternatively, through concessional financing (i.e. providing government-funded facilities that banks can use to re-finance renewable energy technologies). To make such a policy work in practice, a financial institution must disclose in full their climate-related financial risks..

Finally, it is worth recalling that if the transition will require time to take off (Acemoglu et al. 2012), the eventual presence of environmental climate damages,(which depend on temperature variations linked to GHG emissions which have, for the most part, already been emitted)could both increase or reduce the likelihood of transition itself. Which way such effect goes mainly depends on the effects of damages on energy demand. Some climate damages will increase energy demand (Auffhammer and Mansour, 2014) and thus reduce the likelihood of a transition and, ceteris paribus, make carbon taxes and green subsidies less effective (Lamperti et al. 2018b). In addition, the price of fossil fuels influences the likelihood of a shift in a non-linear manner: small price variations have a low impact on inducing the transition, while moderate/high variations could increase both the likelihood, and the rate, of a green transition substantially. Furthermore, the burden of investments required by a transition should also account for adaptation investment and – assuming that climate change would affect the economy – that direct damages can erode or divert resources (Dietz et al. 2016, Lamperti et al. 2019a,b). It must be recognised, though, that such costs would be present also in a no-transition, business-as-usual pathway. In light of these results and discussions, any proposed green transition policy mix should take into consideration how climate damages and other impacts might alter the effectiveness of various policy instruments.

Within the landscape outlined, a set of models to explore the impact of policy solutions aimed at fostering green technologies, infrastructures and R&D activities, and diffusing low carbon energy

technologies becomes crucial. In particular, to support policy design concretely, it is necessary to shift attention from the analysis of a simple carbon tax (or mix of tax and subsidies) that simply internalize the environmental costs, to a more complex set of policy mixtures, where the government and other regulators can enter as active players in shaping the direction of finance, taking risks and favouring investments (see Balint et al. 2017 and Lamperti et al, 2018a,c on the modelling side; and Campiglio et al. 2018 and D'Orazio and Popoyan 2019 for two discussions of policy options within the financial system).
For example, Lamperti et al (2019) proposed a careful comparison of so-called market based (taxes and monetary incentives) and so-called command and control (regulation and enforcement) policies in fostering a green transition. They find that market-based policies are rarely successful in redirecting technical change from brown to green energy generation. Within a market-based approach, which is reliant on the cumulative nature of technical change, a low carbon transition can be triggered only within a limited window of opportunity, when the productivity gap between brown and green technologies is sufficiently small. The time for effective interventions gets shorter the more it is possible for renewable energy to directly substitute fossil fuel energy, thereby focusing policy-maker and innovator attention on the increasing size of the energy grids connecting large plants to the myriad of small green energy producers around the EU (see also Ciarli et al 2018). Conversely, command-and- control policies can always actively redirect technical change toward the green sector.

Such results support the idea that policy interventions aimed at modifying the relative profitability of green vs. brown technologies (e.g. increasing the cost of fossil fuels) might not be an adequate instrument to significantly affect the likelihood of a transition. In turn, large government spending in promoting green R&D is advisable but it should be complemented by strict and ambitious environmental regulations and systemic policy coordination. As emphasized in Schmidt et al. (2012), there is also empirical evidence that simple cost-internalization policies, such as carbon taxation, have limited and even controversial effects, such as causing near-term extraction or emission, while long-term emission reduction targets are a key determinant of corporate innovation activities towards low carbon technologies. Technology policy therefore emerges as an integral element of the policy mix, complementing climate policy. A mission-oriented approach, coordinating local, national and international public bodies across a variety of policy instruments touching multiple sectors (e.g. energy, financial, university-level research), setting the agenda and actively engaging in the selection of projects and finance, would strengthen the likelihood of the transition, while contemporaneously contributing to the knowledge accumulation process that will foster tomorrow's economic growth.

4. Policy Insights

Drawing on the discussions of Sections 2 and 3, we derive here a series of policy relevant insights.

1) In fostering a transition to low carbon energies, so-called market-based policies (carbon taxes and subsidies towards clean sectors) may not be enough and may suffer from being set within a bounded window of opportunities. Delays in their implementation make them completely ineffective both in redirecting technical change, and in avoiding environmental catastrophes.

2) So-called command-and-control interventions can always guarantee shifts to green energy technologies irrespective of the timing of their introduction. As such, they should be seen as a valuable alternative to market-based interventions.

3) The presence of environmental or physical climate damages can potentially reduce the likelihood of transitions, mainly by increasing overall energy demand. Furthermore, climate damages reduce the amount of available financial resources and likely increase needs for adaptation investment, thereby enlarging the financial burden of the transition. In such a framework carbon taxes and green subsidies less effective than command-and control interventions should be included in the policy mix.

4) The quality of finance differs between actors and is not neutral: different actors invest in different portfolios and therefore set directions in innovation that can be locked in via path dependencies.

5) The quality of finance also matters for the rate of investment, because private sources may need public sources to act as dynamizing counterparts for investment in high risk areas. Institutional investment may not be enough to vastly increase renewable energy investments to a scale consistent with mitigation scenarios. Direct public co-investment is needed.

6) In order to sustain the green transition, public investors must be patient, welcome risk, and have the necessary capacity to sustain temporary losses. At the same time, they should gain a fraction of returns of successful projects.

7) Public direct investments combined with directed procurement policies are more effective than market-based approaches for creating a market for not-yet-competitive low carbon technologies.

8) The sheer scale of public finance casts doubts on the idea that the current transition to a low carbon economy can be only sustained by private finance for innovation with indirect public policies guiding the way. Evidence from the renewable energy sector, as well as from historical technological revolutions, suggests that an active public sector with a network of mission-oriented (the mission here being the energy transition) organizations active across the innovation landscape is necessary.

5. Conclusions

Monetary incentives and private initiatives are not enough to save our societies from the threat of climate change. Large policy interventions are needed, but how should they be framed? Mission-oriented policies, implemented by a 'Green Entrepreneurial State' (Mazzucato 2015) provide an ambitious framing for the transition to sustainable growth. This implies that government and its various bodies, agencies and companies act as leaders, rather than facilitators, of the green transition. Market making and shaping rather than just market fixing means setting a green direction through regulatory measures, directing financing, sustaining activity across the business cycle, and

pursuing a portfolio of pathways towards green, that mobilizes all other stakeholders across society. In other words, the ambition to achieve sustainable economic growth requires government direction and a mission-oriented approach.

The green transition possesses all the desirable features a mission may require (Mazzucato, 2018a,b). It engages the public and aims at achieving a more adequate balance between the environment and economic activity, thereby generating widely spread gains for EU citizens' well-being. It is clearly defined in terms of quantities (CO_2 concentrations, temperature levels, share of renewable energies in the final energy mix) and time (COP21 explicitly pushes signing countries to determine their emission targets up to 2030). Furthermore, the mission of a rapid green transition is ambitious and looks at technological change as its major driver; it is cross-sectoral and involves a wide array of stakeholders that must cooperate in a well-focused network. We would envisage European governments boosting their coordination both upstream with EU institutional bodies and downstream with local public authorities.

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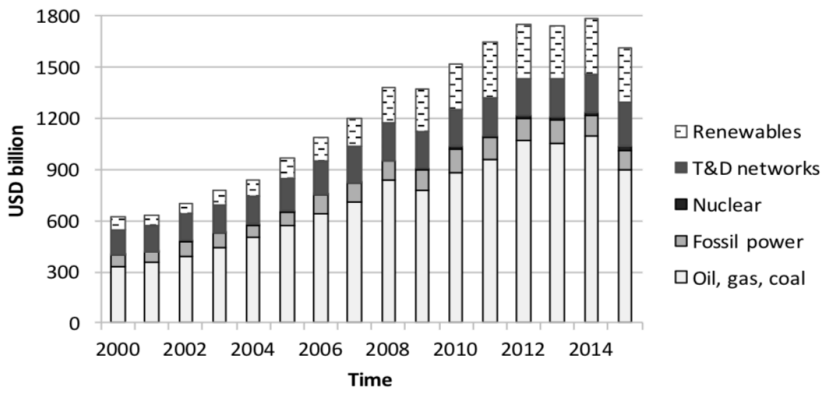
Figures

Figure 1 - Global investments in energy supply by destination (a top) and global investment in renewable energies by area of finance (b bottom). Source: updated Mazzucato & Semieniuk (2018) with data from IEA (2017b), Frankfurt School-UNEP & BNEF (2018)



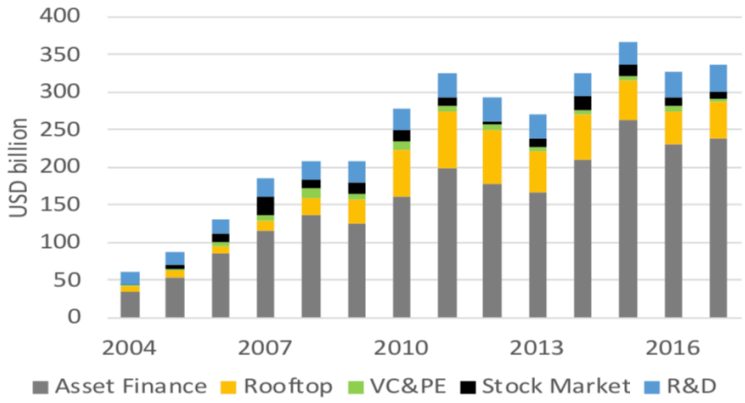


Figure 2 - Scatter of the share of high-risk private renewable energy investments where a public source co-invested (x axis) vs the share of private investments into high-risk assets (y axis) for every year 2004-2014. Source: Mazzucato and Semieniuk (2017)

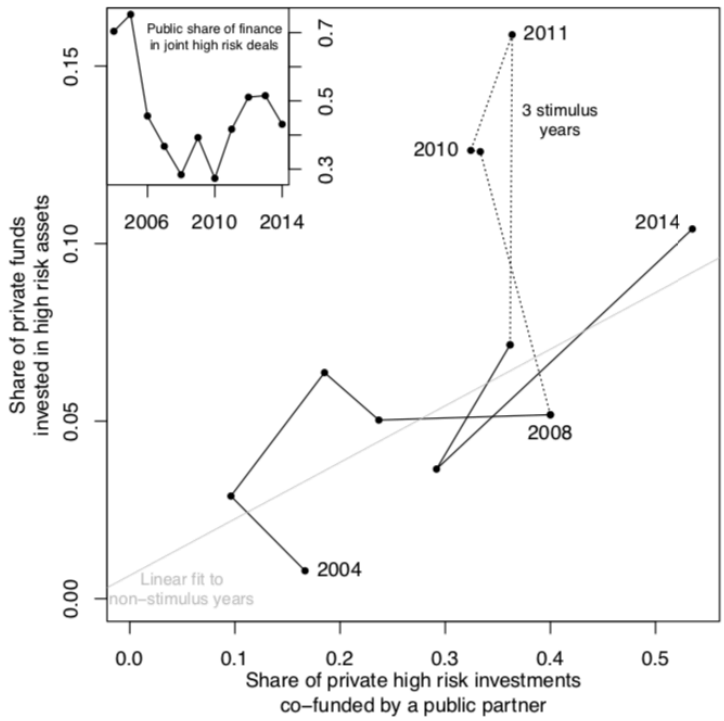


Figure 3 - Global R&D in renewables: wind and marine. Source: Semieniuk and Mazzucato 2018, data from BNEF)

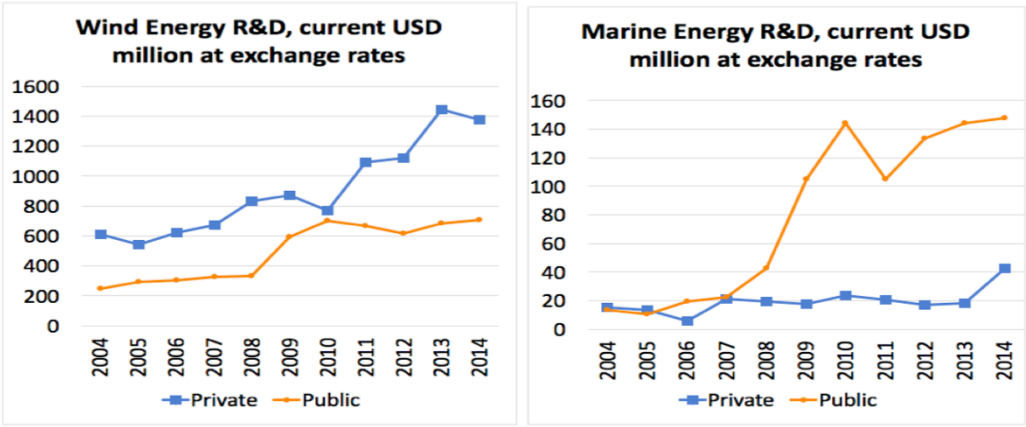


Figure 4 - Share of renewable energies in gross final energy consumption in 2016 by country in the European Economic Area, Switzerland and Turkey. Source: Eurostat.