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A focus on market imperfections can help governments to mobilize private investments in adaptation

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ABSTRACT

Climate change requires significant adaptation of economies, and the largest part of most economies is composed of private sector actors. In this Viewpoint, we argue that it should not be the role of the public sector to cover the full costs of adaptation - which would also typically exceed government's fiscal space. Rather, we suggest that the public sector should set the right conditions to catalyse private investments in adaptation.

While the suggestion is not new, we argue that the current focus on generic 'barriers' hindering more private investments in adaptation is not expedient. These barriers are descriptive rather than explanatory, sometimes mix cause and effect, and tend to focus on eliminating obstacles, rather than adapting efficiently. Alternatively, we suggest to focus on addressing three market imperfections that give rise to those barriers.

In doing so, the overall welfare of society, including the vulnerability of the most marginalized, should be centre-stage. The development of markets should aim to contribute to such welfare - it is not an end in itself. In that sense, our call for a focus on market imperfections is a call for a larger role of public actors, both in developed and developing countries.

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1. Introduction

The public sector has long considered adaptation to be a public response to climate change (Khan, 2015). However, adaptation costs are too high to be covered by the public sector alone (UNEP, 2016). We argue that it is also not the appropriate role of the public sector to cover all costs, as it is in the self-interest of private actors to adapt. Instead, the public sector should (1) provide a stable and attractive regulatory framework necessary to catalyse private investments in adaptation and (2) potentially intervene in areas that are not attractive for private investors. This includes investments where the social benefits are higher than private cash flows or where particularly vulnerable or marginalized communities need help.

Literature argues that there is a shortfall in investments in adaptation; that progress on adaptation financing is slow; and that mobilizing additional private investments in adaptation is challenging (Ahenkan et al., 2018; Bisaro & Hinkel, 2018; Micale et al., 2018; Pauw, 2017; UNEP, 2016). Literature had already discussed a 'seemingly endless' list of barriers to adaptation in general (Biesbroek et al., 2013, p. 1119) and later also started to discuss 'barriers' that specifically prevent private investments in adaptation from materializing (see, e.g. Antwi-Agyei et al., 2013; Biagini & Miller, 2013; Hallmeyer & Tonkonogy, 2018; PCIR, 2012; Stenek et al., 2013; Trabacchi

& Mazza, 2015; Vivid Economics, 2015). However, there is no evidence that these insights into barriers have effectively led to increased private investments in adaptation.

Therefore, we offer a perspective on mobilizing private finance for adaptation that focuses on addressing market imperfections which give rise to those barriers. This moves the focus away from simply mobilizing more private adaptation finance towards identifying market forces that innovate and direct investments towards adaptation, in ways that maximize the overall welfare of society.

A focus on market imperfections should not be confused with arguing in favour of an 'adaptation market'. That theory considers adaptation as a tradeable commodity. Although there are positive experiences with cost-benefit analysis of adaptation measures (e.g. UNFCCC, 2011; Zhou et al., 2011) and value-for-money assessments (Savage, 2015; Watkiss et al., 2014), it is unfeasible to commodify and trade adaptation, partly also because it is multifaceted and locally contextualized (Persson, 2011). In addition, there are many adaptation-related areas where market principles should not play a dominant role. For example, where governments have purely distributional goals, such as immediate disaster response. Governments also have legal obligations for protection (e.g. against coastal flooding, see Bisaro & Hinkel, 2018). Purely commercial markets will never be able to deliver adaptation at the socially optimal level.

The Viewpoint builds on literature and practical examples where addressing market imperfections has mobilized private investments in adaptation at a micro-level. It is out of the scope to provide a detailed and comprehensive analysis of current or potential financial policies and instruments. We argue, however, that such an analysis should be undertaken in future work, and our contribution is meant to inform and stimulate this.

This Viewpoint is structured as follows: the next section introduces the private actors and briefly discusses the major investment barriers identified in adaptation literature. Section three extends this narrative, introducing the economic perspective through market imperfections and how to address them. The last section provides some concluding remarks.

2. Barriers to private adaptation investments

The private sector encompasses a wide range of actors with different stakes in implementing, financing and supporting adaptation. For the sake of clarity of the argument in this Viewpoint we simplify the different roles that components of the financial system play in adaptation to a general rather than a comprehensive view. Private enterprises in the real economy demand finance for their adaptation activity; and commercial, typically private financiers, supply finance. Here, we consider private adaptation finance occurring between those actors, through various financial instruments that, at a general level, can be classified primarily as debt or equity (Bisaro & Hinkel, 2018). Longer-term contracts between public and private actors, for example for green bonds or in public-private-partnerships are not addressed here. How investors deploy their capital in this context is largely driven by risk-return considerations, and a number of other investment characteristics such as correlation with other assets, liquidity of the financial instruments or market size (for an overview, see, e.g. Ameli et al., 2020).

All private enterprises, be they individuals (e.g. farmers and fishermen), micro- small and medium enterprises (MSMEs), or multinationals increasingly need to invest in adaptation. Protecting assets from direct or indirect climate risks, or capitalizing on new business opportunities that have arisen as a result of climate change determines financial flows between key actors in the economy (Pauw, 2017).

Literature discusses how the public sector should address the 'barriers' that prevent private investments in adaptation from flowing. Barriers repeatedly mentioned in literature can be clustered into seven types (see Druce et al., 2016 and Table 1):

- **Financial barriers** are adaptation-specific financing challenges related to, e.g. long-time horizons and high upfront investments, as well as non-adaptation specific issues such as budget constraints and/or lack of access to credit.
- **Information barriers** include information and knowledge gaps pertaining to climate change, potential impacts and adaptation options.
- **Institutional barriers** refer to general shortcomings in institutional arrangements and governance, in the public and/or private space.

- **Policy and regulation barriers** broadly relate to adverse effects of policy and regulation on the business motivations to invest in adaptation.
- **Technological barriers** concern lacking availability of, or access to, advanced technologies, tools and structures.
- **Social and cultural barriers** is another broad category that refers to social and cultural processes that inhibit stakeholders' reactions to climate change.
- **Internal capacity barriers** refer to non-optimal internal management and operational capabilities to meet goals.

The focus on these barriers has major limitations. In this Viewpoint, we focus on the limitation that these barriers are often descriptive rather than explanatory. As a consequence – when looking at why adaptation fails – they sometimes mix cause and effect. Financial barriers, for example, describe that an adaptation project might not happen because nobody is willing to invest. While this may be a correct description, it does not explain the underlying reasons. It could be that the project is unattractive for private investors because it increases social welfare, for example by providing a public good, rather than generating a private return. It could also be that a lack of a properly functioning banking system capable of realizing the commercial attractiveness prevents an investment from materializing. The 'financial barrier' in the first example can be explained by the public good market imperfection (positive externality), and in the second example the lack of an efficient and liquid financial market. Understanding the true cause of the barrier will be important to overcoming it. This view also puts addressing private adaptation into the close overall context of economic development.

The barriers literature also tends to focus on eliminating obstacles, rather than adapting efficiently. For example, Antwi-Agyei et al. (2013) mention a lack of institutional capacity as an institutional barrier and Islam et al. (2014) mention budget constraints and limited access to formal credit as financial barriers. While these issues might be of particular relevance in these authors' studies and other cases, it can *always* be argued that institutions should be improved, or that there are budget constraints.

As the adaptation challenge grows in the face of ongoing climate change, we argue that it is important to adapt efficiently and in the context of the overall welfare of society as a whole, rather than on maximizing private sector investments in adaptation by eliminating obstacles. Rather than discussing 'barriers', we argue that the focus should be on market imperfections that keep markets from functioning efficiently.

3. Addressing market imperfections to eliminate barriers

Market imperfections create distortions in the risk/return profiles of investments and can lead to under-investment – a level of investment that is lower than the economically efficient level. Three particularly relevant observed market imperfections inhibiting adaptation-related activities are: positive externalities, imperfect financial markets and incomplete or asymmetric information (see Druce et al., 2016).

Table 1. Barriers towards mobilising private sector investments in adaptation. Source: Updated from Druce et al. (2016) with new literature, including through an online search for literature on adaptation that addresses both 'barriers' and 'private sector'. The table presents an illustrative selection of the most relevant publications rather than an exhaustive overview.

Type of the barrier	PCIR (2012)	Antwi-Agyei et al. (2013)	Biagini and Miller (2013)	Stenek et al. (2013)	Islam et al. (2014)	Tabacchi and Mazza (2015)	Vivid Economics (2015)	Hallmeyer and Tonkoney (2018)	Ahenkan et al. (2018)	Bisaro and Hinkel (2018)	Moser et al. (2019)
Financial	Provision of public goods, split incentives	Lack of resources; limited availability of formal, market rate loans to MSMEs	Financial time horizons shorter than can be obtained from climate science and models	Lack of economic incentives	Budget constraints; limited access to formal credit	Funding, revenue and risk coverage gap	Lack of donor co-financing; lack of long-term debt		Access to finance	High upfront investment costs; provision of public goods; long time horizons; currency risks	Limited return on investment; incoherent risk structure
Information	Imperfect information	Lack of climate data; lack of awareness of climate change and – risks	Lack of reliable climate projections at the scale of a business activity	Lack of data and information		Knowledge gaps	Lack of awareness and capacity; asymmetric information		Poor knowledge base		
Institutional	Shortcomings incl. accountability and transparency, coordination and community involvement	Lack of institutional capacity	Some short-term options to reduce risks are within the realm of governments (e.g. improving storm warning systems).	Path dependency in/for institutional arrangements	Lack of access to markets		Shortcomings incl. institutional competition, layered bureaucracy and entrenched rules	Poor institutional environment	Weak collaborative effort		governance structures are lacking to receive and manage complex financial interactions
Policy & Regulation	Lack policy and regulatory barriers	Top-down government approach not effective locally		Lack of policies (standards, codes, zoning, permits)	Lack of legal and regulatory enforcement	Policy gap; policy distorting price signals			Inadequate incentives; absence of clear-cut policy	Unclear distribution of liabilities; uncertain regulatory and legislative environment	Construction risks
Technological		Top-down Government approach not effective locally		Lack of policies (standards, codes, zoning, permits)	Technological limitations in accurate weather and climate forecasts			Lack of technical capacity to implement or use technology			
Social & Cultural	Behavioural barriers	Technology not applicable to local context			Lack of education/skills; ethics and coercion						
Internal Capacity Barriers			Lack of knowledge and capacity to evaluate climate science					Preventing companies to offer adaptation products and services at larger scales			

The identified market imperfections may be addressed in two different ways: (1) modify the market environment, for example by reflecting positive externalities in the return or (2) address the consequences of the imperfection through compensation, for example through offering government based financing support or risk sharing. On top of addressing market imperfections, governments also have distributional responsibilities, including reducing the vulnerability of the most marginalized. Associated policy objectives such as equity (just allocation of resources) or affordability of essential goods such as water (see Osberghaus et al., 2010) can also create market imperfections. For example, supply-demand driven water pricing would seem absurd in many developing economies in particular. In Bangladesh, the water price is not determined by the market but fixed by the government at a lower price. From the perspective of a water-intensive company, however, this makes investing in efficient water infrastructure less attractive. A policymaker may decide to accept the market imperfection (artificial low price) and subsidize investment in water-efficient infrastructure to compensate the effect of this market imperfection (insufficient water infrastructure investment).

The next sections explain the three market imperfections and provide examples on how to address these through market environment modifications or compensation.

3.1. Positive externalities

Positive externalities occur when private investments generate public goods: benefits to society that do not necessarily generate additional cash flows and hence are not captured by the financial return (see Varian, 2010). Public good characteristics of adaptation investment vary greatly across time (short-term to long-term), geographic space (i.e. at local, national or regional level) and adaptation strategies (Woodruff et al., 2020). Among a study of 101 business cases on private investments in adaptation, 79% provided benefits beyond the investor (Pauw, 2017). For example, one of these business cases, by Cook Composites and Polymers Co., aimed to replace its ageing storm-water management infrastructure with a wetland ecosystem. This ecosystem also generates public goods that do not generate cash flows: it reduces the burden on the local public water treatment system, whilst providing a natural amenity.

Positive externalities can also appear in the form of technology spillovers, when investments do not generate a return, but do provide lessons learned to third parties. For example, the pharmaceutical company GlaxoSmithKline conducts research and development (R&D) for diseases in developing economies, which may become more prevalent due to climate change. The (potential) result of R&D may be to understand disease transmission patterns or developing new vaccinations. Other pharmaceuticals can subsequently learn from these results; a technological spillover that cannot be priced in to the original R&D investment or compensated for (Druce et al., 2016). It is important to address positive externalities because investors might be held back when public good provision is not reflected by the return on investment, ultimately resulting in increased public vulnerability (see Tompkins & Eakin, 2012).

Negative externalities can also occur if a private adaptation-related activity does not take into account the negative impacts on others. For example, private actors constructed a dike around their industrial estate in Ayutthaya in Thailand to protect against floods, which increased the risk of those living in flood-prone areas just outside of the dike (Druce et al., 2016). Similarly, moral hazard, or inappropriate risk taking behaviour of those that are insured (Noble et al., 2014) can be considered as a negative externality of an adaptation-related activity. In this specific case, it causes investments to rise beyond what can be considered optimal.

Recognizing the externalities of different adaptation strategies and measures helps to identify opportunities for policy and financing mechanisms in order to remove or decrease market imperfections (see Bisaro & Hinkel, 2018; Woodruff et al., 2020). For example, a project or company could charge fees for the positive externality in order to improve the return on investment. In 2001, the Government of Malaysia developed the concept of a mixed-use tunnel that allows for traffic flow under normal circumstances, and that provides for storm water diversion during heavy rains. Private investments were secured by allowing a portion of the tunnel to be tolled for traffic, as these covered the operation costs and repaid the companies' investments (Gardiner et al., 2015). An alternative way to compensate for positive externalities is to use public finance instruments such as grants or subsidized loans to bring down the cost of capital and increase the expected return on investment. For example, the Kayonza Growers Tea Factory in Uganda implemented wetland protection measures to prevent soil erosion, floods and increase water storage that also benefits the wider community. The factory might not have made this investment itself as there was no return on investment. Instead, the project received public grant finance through the Gesellschaft für Technische Zusammenarbeit (GTZ) and the charity Comic Relief. The size of the investment subsidy should reflect the value of the public good (or positive externality) provided by the project.

3.2. Incomplete and/or asymmetric information

In economics, incomplete and/or asymmetric information occurs when critical information is unavailable, inaccessible, or distributed unevenly among different actors (see Akerlof, 1978). In the case of adaptation, this concerns information on climate change; its direct and indirect impacts; potential adaptation responses and associated costs; or people's vulnerability, -risks and adaptation priorities. Unavailability, inaccessibility or uneven distribution of information among relevant actors disempowers them from making adaptation decisions and investing accordingly, in particular in developing economies (Antwi-Agyei et al., 2013; Pauw, 2017; Stenek et al., 2013).

Information needs to be accessible and distributed equally among both enterprises in the real economy and the private financiers, in order for investments to materialize. Relative to the (small) financial volume that is often required for adaptation, the efforts of the financier (often a bank) to understand and evaluate climate-related risks case-by-case are high, thus reducing the attractiveness of lending (Druce et al., 2016). In

individual cases, (long-term) business relationships might help to overcome this situation. For example, Canevari-Luzardo (2019) recorded a case of a cassava farmer that received a direct loan from one of his buyers, to be used for the investment of an irrigation system. The advance payment was paid back with the provision of the raw product. However, this seems to be the exception that proves the rule: MSMEs, which form the backbone of many developing economies, often already face difficulties in accessing finance (Chadhury, 2018).

We argue that public actors should curtail information incompleteness and asymmetry by raising the knowledge and awareness of private actors. For example, in 2011 the IFC provided technical assistance by analysing potential climate risks and opportunities the Maritimo Muelles El Bosque port in Cartagena (Colombia) and identified economically viable adaptation options. Based on this information, the port owners' awareness of the climate risks to their infrastructure increased, and they consequently invested USD 30 million through a commercial loan (Druce et al., 2016). Both public and private actors are already providing climate services that support adaptation by reducing incomplete and asymmetric information. However, climate services are supply – rather than demand driven and the climate services market needs public support to grow (Lourenço et al., 2015). Farmerline for example provides climate services to Ghanaian (small-holder) farmers through their mobile phones and was launched in 2013 after it received a grant award from the UK-based foundation Indigo Trust (Pauw, 2017).

3.3. Imperfect financial markets

Complete and efficient financial markets are important in order to guide investment to where it is needed the most. Therefore, many institutions from government ministries, via central banks all the way to the supervisory authorities are involved in designing and enforcing financial market regulation.

Imperfect financial markets can limit investments in adaptation in many ways. For example, adaptation investments may require long-term debt because climate risks often materialize on longer time-scales. This is at odds with the short-term maturity preferences of the market (Biagini & Miller, 2013) and a big challenge for developing economies that often lack a liquid, long-term financial market (Kempa & Moslener, 2017).

Financial market imperfections such as asymmetric information might lead to financing being held back (Haas & Kempa, 2020). For example, a lack of awareness of climate change and its impact on clients is a serious challenge for microfinance institutions (Helwig et al., 2020).

The insurance sector is also important for financial markets to function, as it allows private actors to hedge risks that they cannot influence. The insurance sector has been more successful than other sectors in building new adaptation business models (Pauw, 2017), for example by developing new products such as weather index insurance. Yet they also face imperfect financial markets. Microfinance Institutions, for example, often do not offer such insurance schemes as they are either too expensive to develop or because uptake is low as farmers

often perceive them as too risky (Druce et al., 2016). Insurance options for long-term climate impacts are particularly underdeveloped in developing economies (Surminski & Oramas-Dorta, 2014).

Governments can address imperfect financial markets by shaping the rules for the market such that it becomes more attractive to commercial actors. Climate change has not traditionally been a concern of financial market regulation, but this is currently changing. For instance, in 2017 the Task Force on Climate Related Disclosure (TCFD) has launched a set of recommendations for climate-related financial disclosures that have become the basis for policy development worldwide. The Network for Greening the Financial System (NGFS) is an initiative of central banks who have realized the risk as well as the opportunity for the financial system stemming from climate change and international climate agreements. NGFS is working on macro-prudential as well as micro-prudential climate regulation and the realization of business opportunities. Such regulation of financial markets informs investors on climate-related financial risk and targets improving the functioning of markets.

Alternatively, public finance institutions, such as central banks, public development banks and public pension funds, have the direct or indirect policy mandate to address market incompleteness, market failures, or externalities (Ratnovski & Aditya, 2007). They are equipped with a mandate that is guided by societal rather than commercial goals. They can intervene directly as a market actor and provide long-term lending or cheaper capital, or offer innovative hedging instruments in order to increase the attractiveness of private investments in adaptation. For example, traditional crop insurance products have not been commercially viable and rarely helped rural Indian farmers overcome weather risks (Withey et al., 2009). Innovative weather index insurance, however, requires significant up-front investments. As international reinsurance companies may be reluctant to cover these costs, public support could cover them (Jarzabkowski et al., 2019). The weather index insurance initiated by ICICI Lombard GIC and BASIX in India in 2003, for example, required technical support from the World Bank and federal government subsidies to lower the premium before it could be scaled up to a commercial scale that now covers over 12 million farmers (Kato et al., 2014).

4. Concluding remarks

In order to address increasing global climate challenges, adaptation cannot be treated as an add-on: to adapt efficiently, it should be an integrated part of economic development. The current literature on barriers does not sufficiently explain the current shortfall in private investments in adaptation. It also does not provide orientation on how to address barriers in a way that is efficient and beneficial to the overall welfare of society, instead of just to the private sector actors that would benefit from addressed barriers. In this Viewpoint, we suggest instead to integrate adaptation in general economic development by identifying and addressing market imperfections behind those barriers. These create distortions in the risk/return signals received by the market and can lead to

sub-optimal levels of investment in adaptation. The public sector has a role in identifying and addressing market imperfections and catalysing private investments in adaptation in its role as a regulator and public financial actor.

We would like to make clear that the overall welfare of society, including the vulnerability of the most marginalized, should be centre-stage. The development of markets should aim to contribute to this – it is not an end in itself. In that sense, our call for a focus on market imperfections is a call for a larger role of public actors, both in developed and developing countries, in providing orientation as to where investment is most beneficial from a societal perspective.

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