Evans School Policy Analysis and Research (EPAR)

Policy and Economic Considerations for Global Public Goods Provision in Agriculture and Health in Developing Countries

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Abstract
This paper considers how public good characteristics of different types of research and development (R&D) and the motivations of different providers of R&D funding affect the relative advantages of alternative funding sources. We summarize the public good characteristics of R&D for agriculture in general and for commodity and subsistence crops in particular, as well as R&D for health in general and for neglected diseases in particular, with a focus on Sub-Saharan Africa and South Asia. Finally, we present rationales for which funders are predicted to fund which R&D types based on these funder and R&D characteristics. We then compile available statistics on funding for agricultural and health R&D from private, public and philanthropic sources, and compare trends in funding from these sources against expectations. We find private agricultural R&D spending focuses on commodity crops (as expected). However contrary to expectations, we find public and philanthropic spending also goes largely towards these same crops rather than staples not targeted by private funds. For health R&D private funders similarly concentrate on diseases with higher potential financial returns. However unlike in agricultural R&D, in health R&D we observe some specialization across funders - especially for neglected diseases R&D - consistent with funders’ expected relative advantages.

Introduction
When research and development (R&D) in agriculture and health produces knowledge that can be used repeatedly (non-rival consumption) and is costly to exclude from non-payers (non-excludable), that R&D is considered a public good. Public and philanthropic support for R&D is premised on R&D’s public goods properties: discoveries made through research into crops or farm technologies, or research into vaccines or disease treatments, can offer benefits to a wide pool of beneficiaries simultaneously, but an inability to charge for use of knowledge once created suggests that private markets alone will provide less than the optimal amount (Oerlemans & Meeus, 2001).

From the perspective of a global planner the problem of public goods provision is one of minimizing the total cost of providing the socially optimal level of goods. We begin with the simple premise that private investors seek to maximize profit, public funding has more nuanced political, economic and social goals, and philanthropists are interested in maximizing a social rate of return on investment. A global planning solution thus would seek to finance public goods up to the socially efficient level and prevent duplicative funding. We also assume the costs of excluding non-payers is a continuum, and thus some public goods will be profitable (effectively “club” or “toll” goods), while others will not be provided by the private sector at all (“pure” public goods). Thus we expect private funders will supply a narrower range of goods than public or philanthropic funders, and we also assume that any global solution would avoid crowding out potential market-driven funding for “impure” public goods. Taking these different organizational incentives as given, we use the literature to develop a set of predictions - from the viewpoint of a global planner - for considering how characteristics of agricultural and health R&D, and characteristics of R&D funding providers, affect the relative advantages of alternative funding sources.

Methods
We conducted a comprehensive review of published works on GPG classification, funding, and relative
advantages across funding sources, with an emphasis on agricultural and health R&D in the developing world. To compare predicted funding allocations against funder behavior, for agricultural R&D spending we draw on publicly available industry and donor reports and raw data on public funding from the CGIAR Agricultural Science and Technology Indicators (ASTI) database. We also use data on crop production values and other factors hypothesized to be linked to R&D funding from FAOSTAT. For health R&D spending we consult comprehensive reviews of public and private funding flows by Chakma et al. (2014) and Røttingen et al. (2013), along with raw data from the G-Finder database of funding flows to neglected tropical diseases. Further data on Disability-Adjusted Life Years (DALY) estimates by disease (hypothesized to be linked to R&D funding) are drawn from the Global Burden of Disease (GBD) 2013 report.

Results

Our review of literature suggests that the typology proposed by Sagasti & Bezanson (2001) remains one of the only theoretical frameworks to consider and compare the characteristics of potential sources of GPG spending. In the full paper we build upon this framework, drawing upon more recent work by Kharas & McArthur (2014), Pratt et al. (2012), and Popa et al. (2011) among others to examine the relative advantages and disadvantages of different funders based on characteristics of R&D types.

Characteristics of Funders

On the supply side, funding decisions surrounding different types of agricultural or health R&D may be influenced by the level of upfront costs necessary, the expected timing and size of the return on investment (ROI), and the level of risk associated with those investments (Table 1).

In agriculture, for much of the last century public institutions have been the primary funders of basic agricultural R&D (ASTI, 2016; Beintema & Elliot, 2009). Theory explains this active role as arising from the critical role and social returns that R&D is seen to have in national food security and economic growth and development, prompting public sector action to overcome high upfront costs and high risks (Table 1). Private funding meanwhile has historically played a more limited agricultural R&D role focused on applied research and technological product development - activities that also entail high costs and risk, but typically accrue higher short-term financial returns (Echeverria & Beintema, 2009; El-Sharkawy, 2006; Pray & Naseem, 2003). The role of philanthropy in agricultural R&D meanwhile has at times been quite substantial - with philanthropic funding predicted to have a relative advantage in providing R&D with high costs, high social rewards (especially benefits crossing national boundaries and hence not necessarily considered by state-based public funders), and high risks.

In health both governments and private funders have been active funders of R&D since the 1950s (Moses et al., 2015; WHO, 2004), with private funding playing a growing role globally over the past decade, especially in South Asia. However most health R&D funding focuses on a subset of global diseases - with critics of private funding alleging that less than 10% of total health R&D is dedicated to diseases that affect 90% of the global population (Vidyasagar, 2006; Roach, 2000). Funding for R&D on diseases concentrated amongst the poor in developing countries (including the “big three” (HIV/AIDS, malaria, and tuberculosis) and many other “neglected” tropical diseases1 (WHO, 2015)) primarily comes from public institutions and non-governmental organizations (NGOs) (Moran, 2011; Delisle et al., 2005).

Characteristics of R&D Types

On the demand side, potential beneficiaries of agricultural and health R&D span countries with vastly different public resources, individuals with vastly different income levels, and markets with vastly different private financial potential (Wright et al., 2007). Areas with lower potential financial returns for private investment may require more spending by external public or philanthropic sources, especially for public goods that are more regional than global (Barrett, 2014; Delisle et al., 2005) - for example, R&D for diseases that are concentrated in particular areas or crop traits relevant to particular agroecological zones.

Evidence on R&D Funding Flows

In agriculture, public funds constitute the majority of global R&D funding. The most recent data on public funding for agricultural R&D come from the CGIAR’s 2012 Agricultural Science and Technology Indicators (ASTI) report, which reports global public spending on agricultural R&D as $31.7 billion in 2008 (versus roughly $11 billion in total private funds). Approximately half of public R&D funding in 2008 (51%) came from high-income countries and the rest from low- and middle-income countries. As summarized in Figures 1-2, country-level public funding to agricultural R&D in Sub-Saharan Africa and South Asia (measured as publicly funded full-time equivalent (FTE) researchers) is concentrated in commodity grains and other market-oriented crops - crops where private funding is expected to have a relative advantage. One exception is the relatively high public R&D support for “Other Roots and Tubers” in Sub Saharan Africa - although relative to production value R&D for roots and tubers is still low compared to rice, maize or
Data on philanthropic investments in agricultural R&D are limited, but largely concentrated on commodity crops, again potentially overlapping with public and private funding.

In health, private funds provide a majority of overall health R&D worldwide (Røttingen et al., 2013), but most private investment targets non-communicable chronic diseases, especially cancer (Jamison et al., 2013). The public sector provided $2.165 billion (64%) of all funding for neglected disease R&D in 2014 (G-Finder, 2015), and the vast majority of funding for neglected tropical diseases excluding the “big three” (HIV/AIDS, malaria, and tuberculosis) came from philanthropic sources (most prominently the Bill & Melinda Gates Foundation).

As summarized in Figure 3, our results suggest public, private, & philanthropic neglected disease R&D spending show associations with disease-specific DALYs (with some of the highest DALY values attracting some of the highest research funding from all sources), and also provide some evidence of funders specializing in different health R&D types - or at least responding to other funders’ behaviors. For example HIV/AIDS receives by far the largest amount of public investment, and the lowest amount of private investments, among the “big three.”

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2. References and further details on philanthropic investments in agricultural R&D and health R&D are provided in the full report.
Conclusions

Ultimately, there is little consensus surrounding the “best” ways to ensure the provision of R&D with public good characteristics, particularly R&D of relevance to developing countries in Sub-Saharan Africa and South and Southeast Asia. Only a small body of literature addresses the relative advantages of funding options for providing global public goods (GPGs) (Anand, 2002; Mondiale, 2001; Sagasti & Bezanson, 2001), and an even smaller literature examines alternative funding options for GPGs specifically relating to agricultural and health R&D (Buckley et al., 2014; Naseem et al., 2010; Spielman & Pandya-Lorch, 2010; Delisle, 2005).

Provision of R&D by the private sector is particularly problematic in low-income countries including much of Sub-Saharan Africa (Barrett, 2014; Spielman & Pandya-Lorch, 2010; Paarlberg, 2002), even though several authors argue that returns on investment in the region may be high for agricultural R&D (Miller et al., 2010; Evenson, 2001) and for health R&D (Norris et al., 2012).

Figure 3. Allocation of Private, Public and Philanthropic R&D Funding to Neglected Diseases (with DALYs shown).
Table 1. Relative Advantage of Funding Source by Characteristic of the Public Good

<table>
<thead>
<tr>
<th>Characteristics of the Public Good</th>
<th>Provision Status</th>
<th>Costs</th>
<th>Return on Investment</th>
<th>Level of Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Private Funder</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Best-shot&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Potential to cover high initial costs</td>
<td>Financial</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td><strong>Public Funders</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Public: High-Income</strong></td>
<td>Weakest link&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Mixed hypotheses</td>
<td>Social</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Public: Low-Income</strong></td>
<td>Best-shot&lt;sup&gt;b&lt;/sup&gt;; summation&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Limited ability to cover high initial costs</td>
<td>Social</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Public: International Organizations</strong></td>
<td>No theory</td>
<td>Potential to cover high initial costs</td>
<td>Social</td>
<td>No theory</td>
</tr>
<tr>
<td><strong>Philanthropic Funder</strong></td>
<td>Best-shot&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Potential to cover high initial costs</td>
<td>Social</td>
<td>High</td>
</tr>
<tr>
<td><strong>Partnerships</strong></td>
<td>Summation&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Mixed hypotheses</td>
<td>Social &amp; Financial</td>
<td>High</td>
</tr>
</tbody>
</table>

Source: Adapted from Pratt et al., 2012; Sandler, 2003; Sagasti & Bezanson, 2001; Mondiale, 2001; Rausser, 1999

<sup>a</sup> For *weakest link* goods the smallest effort determines the public good level; examples include agricultural quality standards, or the eradication of a disease.

<sup>b</sup> For *best shot* goods the largest effort determines the public good level, for example with agricultural research and development or funding the cure to a disease.

<sup>c</sup> For *summation* goods the overall level of public good equals the sum of country contributions, for example mitigating climate change, or building a database of health indicators.

Table 2. Characteristics of Agricultural and Health R&D Types as Public Goods

<table>
<thead>
<tr>
<th>Characteristics of the Public Good</th>
<th>Provision Status&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Costs</th>
<th>Financial Returns</th>
<th>Level of Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Agriculture R&amp;D</strong></td>
<td>Best-Shot</td>
<td>High</td>
<td>Varies</td>
<td>High</td>
</tr>
<tr>
<td>Cash Crops R&amp;D</td>
<td>Best-Shot</td>
<td>High</td>
<td>High - Private</td>
<td>High</td>
</tr>
<tr>
<td>Commodity Crops R&amp;D</td>
<td>Best-Shot</td>
<td>High</td>
<td>Varies</td>
<td>High</td>
</tr>
<tr>
<td>Subsistence Crops R&amp;D</td>
<td>Best-Shot</td>
<td>Medium</td>
<td>Low - Public</td>
<td>High</td>
</tr>
<tr>
<td><strong>General Health R&amp;D</strong></td>
<td>Best-Shot</td>
<td>High</td>
<td>High - Private</td>
<td>Varies</td>
</tr>
<tr>
<td>“Big 3” Diseases R&amp;D</td>
<td>Best-Shot</td>
<td>High</td>
<td>Varies</td>
<td>Medium</td>
</tr>
<tr>
<td>Neglected Diseases R&amp;D</td>
<td>Best-Shot</td>
<td>High</td>
<td>Low - Public</td>
<td>High</td>
</tr>
</tbody>
</table>

Source: Adapted from Kharas & McArthur, 2014; Pratt et al., 2012; Popa et al., 2011; Sandler, 2003; Sagasti & Bezanson, 2001; Mondiale, 2001; Rausser, 1999.

<sup>a</sup> Most R&D efforts constitute *best shot* goods, whereby the single largest effort determines the public good level.
Endnotes

1 We use a definition of neglected diseases which includes the “big three” - HIV/AIDS, malaria, and tuberculosis - as well as 17 other diseases identified by the World Health Organization as “neglected diseases” (G-Finder, 2015; WHO, 2015), 6 of which are included in G-Finder’s annual survey on neglected disease R&D spending.

2 Research investment in roots and tubers is also largely concentrated in Nigeria alone, even though roots and tubers are important subsistence crops across Sub Saharan Africa.

References


ASTI (Agricultural Science and Technology Indicators) (2012). ASTI Global Assessment of Agricultural R&D Spending: Developing Countries Accelerate Investment. CGIAR.

ASTI (Agricultural Science and Technology Indicators) (2016). ASTI database. IFPRI.


FAOSTAT (2016). Database.

G-Finder (2016). Database.


