Rethinking innovation policy in India: amplifying spillovers through contracting-out

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Outline

The problem of innovation policy

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- Left to itself, the free market will tend to under-invest in the extremes of human knowledge
- Technical phrases from public economics:
  1. Freedom mostly works well,
  2. Except in the four class of situations termed ‘market failure’,
  3. One of which is a “positive externality”
  4. There are spillovers: My gaining knowledge induces benefits for all around me, but my decisions to obtain knowledge are shaped by my benefits alone.
- This is the rationale for state action, for innovation policy.

The main pools of public funding

- In all countries, the big pools of public funding are classified into (a) space, (b) nuclear, (c) defence, (d) health, (e) pure R&D funding.
- Fairly substantial resources are going through these channels today.
- In this paper:
  1. We suggest there are ways for society to obtain a greater bang for the buck from this existing spending
  2. And that this path runs through the public administration problems of government contracting.

Two ways to send a craft to the moon

Make:

1. Raise money from taxpayers (cost to society is 3×)
2. Recruit scientists and engineers
3. Build the craft
4. Send it up to the moon.

Buy:

1. Raise money from taxpayer (cost to society is 3×)
2. Do skeletal design work to get the minimal high-level parameters
3. Put out multiple contracts to get competing designs
4. A process of unfolding risk
5. Finally, contract out the design to be fabbed
6. Send it up to the moon.

National Aeronautics and Space Administration (NASA) in the US does buy, Department of Space (DoS) in India does make.

Strengths and weaknesses of the "buy" strategy

Strengths:

1. Harness multiple competing teams
2. Explore multiple design pathways
3. More bang for the buck through private energy and management
4. Most important: the knowledge created is *in the society* and not in the state. The spillovers and the positive externalities are the whole point of innovation policy.

Difficulties:

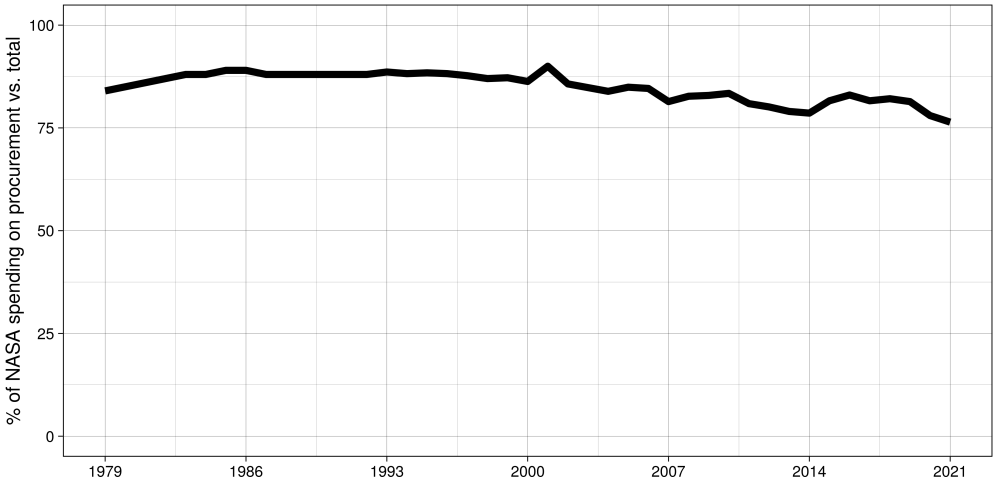
1. How to contract with multiple kinds of energy in India: government research organisations, private research organisations, and private firms?
2. "If there is no possibility of failure, it is not research". How to deal with failed research projects?
3. Accusations, investigations.
4. How to make sure the recipient actually tries hard; does not merely pocket the money?

How NASA works

NASA was created to "buy"

- §102(c)(8) of the National Aeronautics and Space Act of 1958 directs NASA to pursue "the most effective utilization of the scientific and engineering resources of the United States" towards aeronautical and space activities.
- NASA's creators were clear that the most "effective utilization" comes from contracting.
- *"It is natural that our scientists and engineers want to keep to themselves all of the interesting and creative problems, while farming out to industry only the repetitive and straight production items. This does not make sense to me ... even preliminary design contracts could be awarded to industry to round out industry's capabilities. Unless industrial contractors are encouraged to round out their capabilities, NASA will find it necessary to expand its in-house capabilities"* — T. Keith Glennan.

NASA's budget primarily goes towards contracting[1]



[1]Source: NASA Annual Procurement Reports, 1979–2021.

Contract mapping with TRLs: example of Magellan probe

TRL		Action taken (US Government Accountability Office, 1988)
1 – Conception	1966–1978	1 – NASA conducted studies on the feasibility of mapping the topography of Venus. Contracts to Illinois Inst. of Tech, Hughes Aviation and Martin Marietta
2 – Basic principles reported	1978–1979	2 – Success of Mariner probe prompts go-ahead for conceptualisation of mission to create a spacecraft carrying radar imaging equipment to orbit Venus.
3 – Potential applications validated	1979–1980	3 – Joint study with USSR. JPL, Ames, Marietta, and Hughes contracted to supply alternative mission designs.
4 – Proof of concept	1980–1984	4 – Full scale development commences. Launch date planned. Spacecraft contract to Marietta. Radar imaging equipment contract to Hughes.
5 – Laboratory validation	1984–1987	5 – Radar tests done
6 – Simulation/real space validation	1987–1989	6 – Spacecraft tests done
7 – System adequacy in simulation	1989–	
8 – System adequacy in space		8 – Successful launch

Legal basis

- The basis for contracting comes from the Federal Acquisition Regulations (FAR) which is analogous to the Indian General Financial Rules (GFR).
- Multiple award contracts for major systems: under §1834.003 of the FAR, NASA can award contracts to multiple organisations to meet the requirements of a single solicitation. Usually done when time is of the essence and the contractor has a higher capacity to deliver.
- Market research: under §1834.003 of the FAR, NASA has to conduct market research to ascertain if private sector firms can reasonably be expected to generate outputs. This is mapped to specific TRLs.

Types of agreements

- FAR allows for four broad kinds of agreements. NASA has a wide berth to customize these:
  - Contracts: fixed-price and cost reimbursement.
  - Research agreements: grants and cooperative agreements
- In addition to FAR agreements, NASA can enter into Other Transaction Authority (OTA) agreements. Under the Space Act of 1958, OTA agreements are not considered to be "procurements" i.e. the FAR does not apply to them. NASA has enormous freedom to design OTA agreements the way it feels is appropriate (Gunasekara, 2011).

FAR contracts

- Fixed-price contracts (§16.2 of the FAR)
  - NASA will pay the specified price even if actual costs are higher.
  - Risk to and oversight by NASA is low.
  - Test of discharge of contract is *delivery* of goods/services as stipulated.
  - Example: February 2023 contract to SpaceX to supply commercial payload processing services (NASA, 2023).
- Cost reimbursement contracts (§16.3 of the FAR)
  - NASA pays for allowable costs incurred. They sometimes stipulate a cost ceiling.
  - Risk to and oversight by NASA is medium to high.
  - Test of discharge is evidenced by the contractor having made *"good faith efforts to meet government needs"*. Completion is not necessary.
  - Example: July 2019 contract to Bechtel to supply mobile launcher for Kennedy Space Center (NASA, 2019). NASA's engagement with the Jet Propulsion Lab at CalTech is done on the basis of five-year cost-plus contracts which have been renewed at the end of each term since 1958 (NASA, 2018).
- In 1981 70% of all contracts in value were cost-plus-award contracts. In 2021, cost-plus-award contracts constitute 32% of the total value. Meanwhile, firm fixed price contracts have risen from 14% in value of all contracts in 1979 to 32% in 2021 (NASA, 1999; NASA, 2022).

Research agreements

- Grants (31 US Code §6304)
  - NASA is not "substantially involved" in the direction of research. Risk to, and oversight by, NASA is low (Walker, 1997).
  - Information sharing between researchers and NASA is annual, biannual or quarterly.
  - E.g. 2019 award to Georgia Tech to research on sustainable supersonic commercial flight (Georgia Tech, 2022).
- Cooperative agreements (31 US Code §6305)
  - NASA is "substantially involved" in the direction of research. Risk to, and oversight by NASA is substantial.
  - Information sharing between researchers and NASA is frequent, sometimes even daily.
  - E.g. 2018 award to University of Maryland to study comets (University of Maryland, 2021).
- Grants and cooperative agreements constitute an average of 5% of total NASA procurement spending.

Meritocracy in awarding contracts

- The decision to "buy" reflects NASA's preference for the generation of spillovers.
- "Buy" allowed NASA to adopt evaluation processes that reflect true meritocracy regardless of the applicant's profile, size or status.
- Dual anonymized peer review allowed NASA to select proposals that were the best fit. A proposal cannot carry any identification details whatsoever about its proposer, whether they are individuals or organisations.
- Procurement officers are well-trained to manage downstream issues. The US Federal Acquisition Certification in Contracting (FAC-C) is a compulsory qualification all procurement officers are required to have. It takes a year to acquire the certification. After obtaining the certification, the officials are expected to spend 80 hours every two years to complete Continuous Learning Requirements to maintain their certification.

Positive spillovers

- Research spillovers: NASA research funding between 1970 and 1990 directly resulted in 0.2% of total US patent grants. But NASA-funded patents were cited as prior art for 2% of all US patents during this period (Jaffe et al., 1998).
- Development of industries: NASA research directly contributed to the emergence of commercial industries in sectors like semiconductors, aerospace, weather and disaster forecasting etc. (Ginzburg et al., 1976).
- Development of small businesses: Under the Small Business Innovation Research Act of 1982, NASA and other federal agencies have to offer certain favourable contract terms for small businesses engaging in innovation. NASA's adoption of the law improved the rates of commercial success (e.g. better market linkages) for these businesses (Archibald and Finifter, 2003).

Defining failure

- Contract "failure" is possible only with fixed-price contracts. Failure to deliver the goods/services within the given milestone time amounts to non-performance under contract law.
- With grants, cooperative agreements, cost-reimbursement contracts and OTA agreements, making "good faith efforts" is sufficient for contract performance. There is no "failure" other than the failure to make good faith efforts.
- "Good faith efforts" are judged on the basis of the TRL of the project (NASA, 2007):
  1. Research-based TRLs (TRLs 1–3): Dual Anonymous Peer Review. Complete anonymity to be maintained in proposals and research works to carry out blind review.
  2. Prototype-based TRLs (TRLs 4–7): "Support and simulation" test in controlled conditions.
  3. Flight-based TRLs (TRLs 8 and 9): Performance in flight tests.
- When a fixed-price contractor is unable to deliver due to cost/technology constraints, US invisible infrastructure (judiciary, legal systems) results in cases getting settled out of court without admission of liability.

Solutions

Objective

- We propose a tangible set of actions that will bring "buy" to prominence in Indian innovation policy.
- This will be achieved through detailed changes to the law:[2]
  1. Changes to the General Financial Rules
  2. Changes to the founding documents/ cabinet resolutions
  3. Changes that need the creation of new rules
  4. Changes to internal procurement manuals and processes
- We also lay out a fiscal roadmap to visualise numbers for these changes.

[2] Indian bureaucrats are risk-averse. They are "intimidated through overmonitoring" and are "accountable through accounting" due to the investigator's reliance on the "paper trail" when discretionary procurement decisions are made (Sneha et al., 2021). A good solution is legal clarity.

Strategies for transformation

- Five organisations take up more than 80% of Union government research funding.[3]
- A few different pathways in reform are feasible:
  1. Path 1: All five organisations undertake the transformation into "buy".
  2. Path 2: New organisations are started which are buy-oriented from the start. Natural components of the Indian innovation system which are at present lacking are DARPA, NIH, and NSF-equivalents.
  3. Path 3: A combination of change management at one or two old organisations alongside one or two new organisations.

[3] In 2019, 32% of Union research funding went to DRDO, 19% to DoS, 11% to ICAR, 11% to CSIR and 9% to DoAE (Ministry of Science and Technology, Government of India, 2020).

Conclusions

1. One of the most important elements of building a new India is doing better on innovation policy
2. Spending more is always difficult; it's important to ask: Can we get more of an impact on the core objectives of innovation policy (higher capabilities in the Indian *society*) while holding spending intact?
3. The big idea of this paper: Do more "buy" and less "make" in Indian R&D.
4. The value of putting a craft on the moon lies in the inducement of higher capabilities in Indian *society*.
5. We are able to draw on expertise in government contracting in order to offer a first draft of (a) Methods to be used in an Indian funding organisation and (b) Associated reforms required in the Indian 'invisible infrastructure' which shapes the life cycle of the contract.

Thank you

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