Can India become an innovator of consequence?

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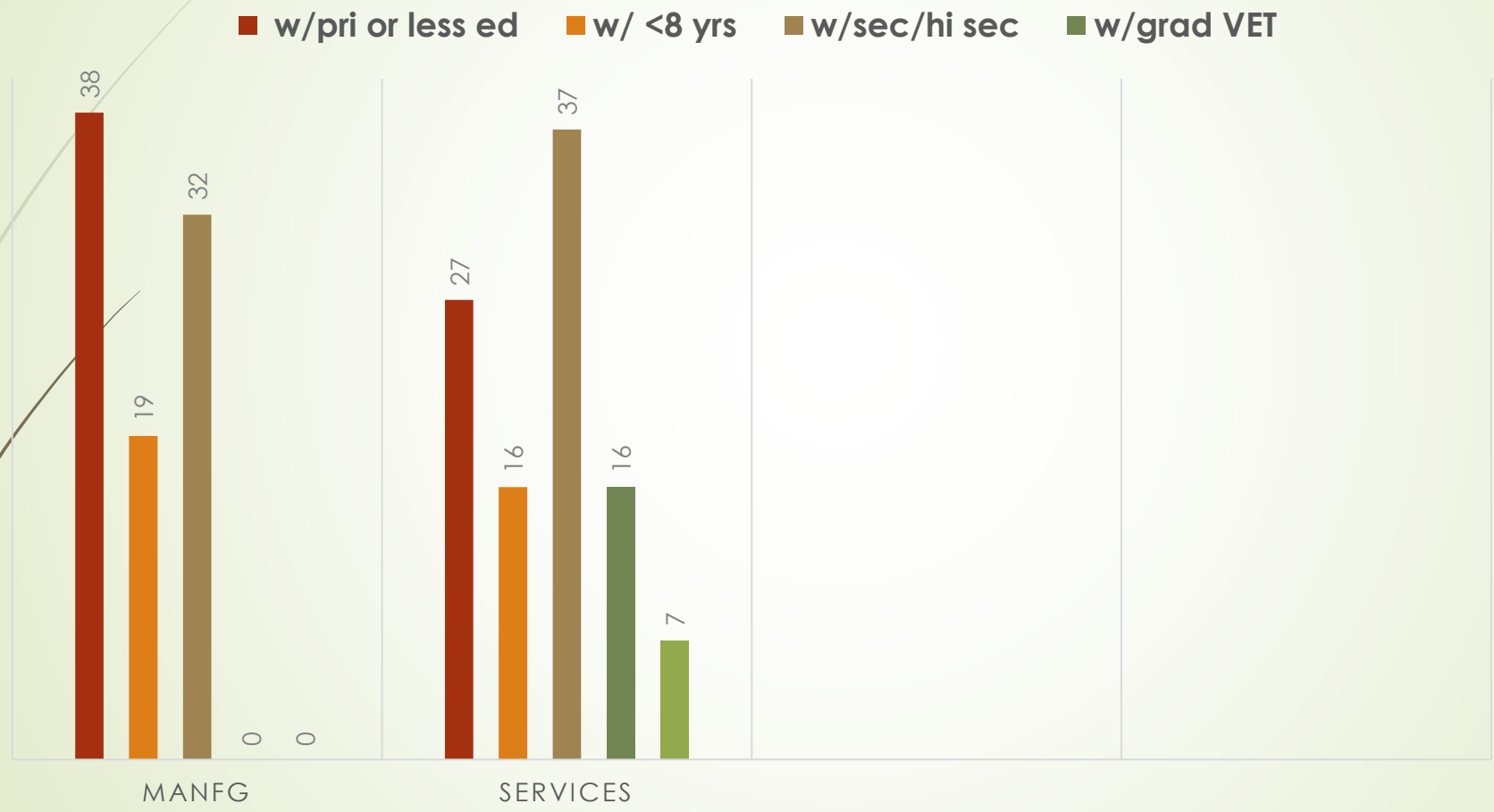
Structure of presentation: STI SUCCESS REQUIRES A NATIONAL INNOVATION SYSTEM…but 4 challenges

- **Challenge 1: Multiple failures have led to poor educational outcomes for current workforce – leaving only 20 years before demographic dividend runs out; despite many recent successes**
- **Challenge 2. Absence of an Industrial Policy has prevented India from becoming a manufacturing hub; leaving innovation stunted**
- **Challenge 3: An underfunded R&D system, overly dependent upon publicly-funded R&D, that has no way to convert patents into commercially viable technological solutions**
- **Challenge 4: Private corporate sector – with exceptions – is under-invested in Design Capacity but also R&D**

STI in India: Some successes…but India a consumer, not producer, of knowledge in recent decades

- One of the most important innovations in the history of math – the zero.
- Independent India has chalked up many accomplishments:
  - the nuclear energy program (incl indigenous nuclear deterrent programme – unlike Pak),
  - the hybrid seeds program that underpinned the Green Revolution in agriculture
  - the space program (e.g. Satellite manfr/launch for telecom & meteorological use, & Mangalyaan mission to Mars, which highlighted India's niche of doing cost-effective, high-tech research)

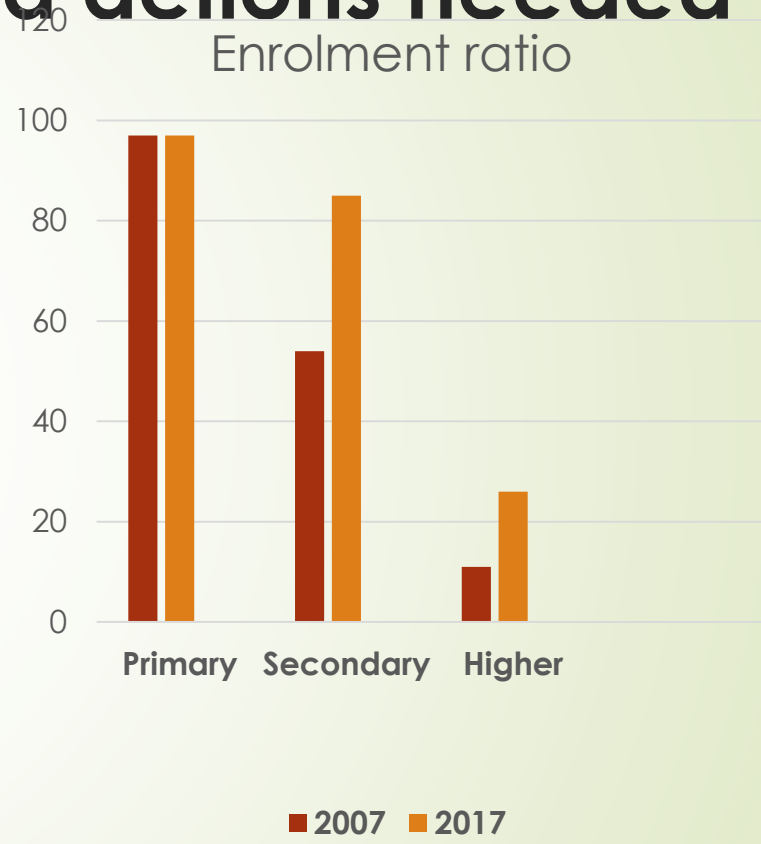
CHALLENGE 1: SHARE OF WORKFORCE BY LEVEL OF EDUCATION



Good News: **Education & skills base has been estd: now STI related actions needed**

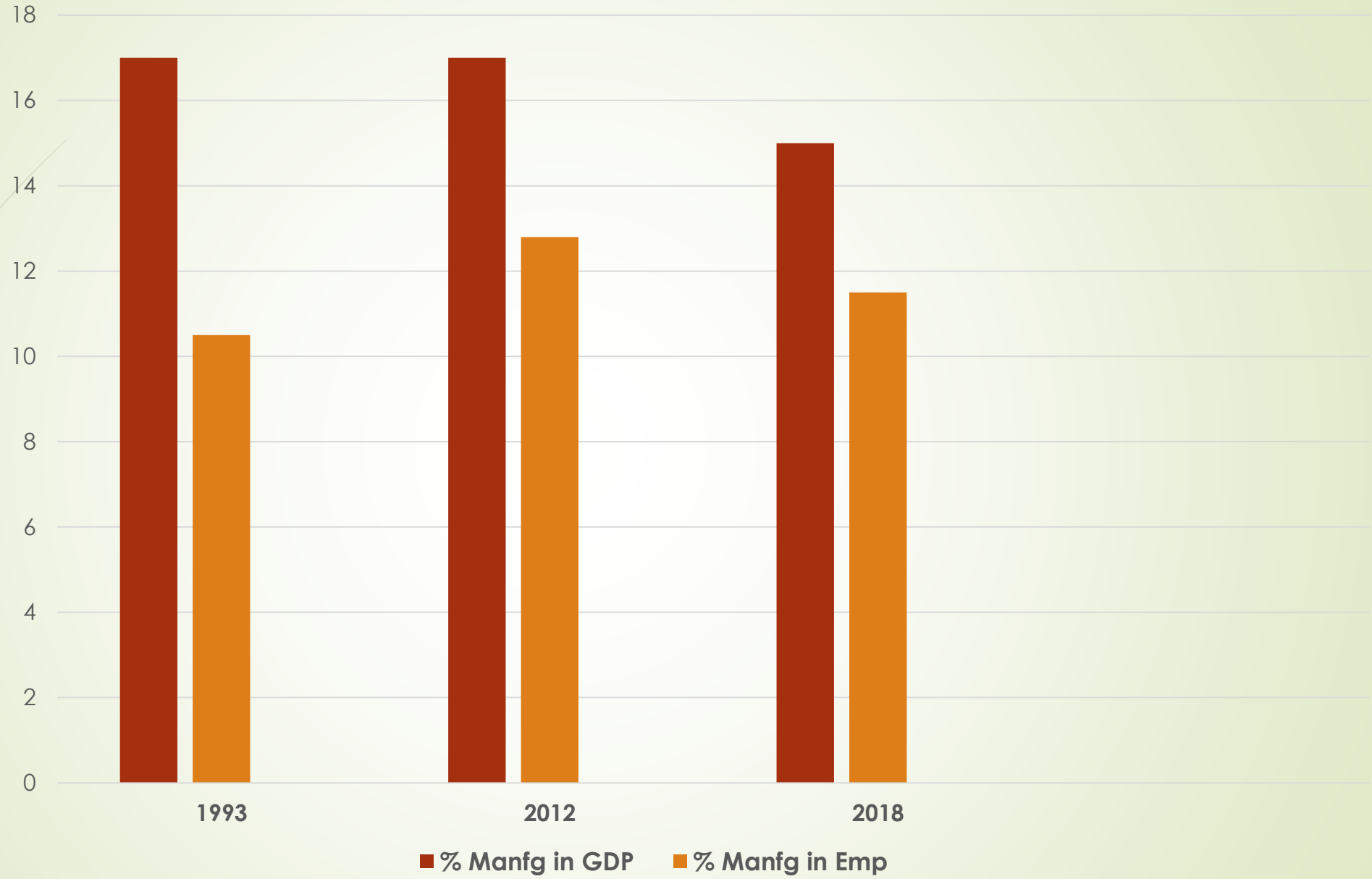
- **Massification of Hi Educ has not meant learning levels are high; Serious shortages of STEM teachers at sec/hi sec level;**
- **53% enrolment in tertiary educ is in social sciences & humanities/law/business; while engg, manfg, science 39% (of which science 5%)**

- **NEEDED – much greater investment in education; 4% of GDP wont suffice;**
  - **Structural shifts needed to align Industrial Policy to Educ/Skills policy for STI:**
  - **early diversion into TVET; focus on STEM in hi ed**
- **India's STRENGTH: over 800 MNCs located global R&D Centres in India (skilled lab, cost, IPR)**



Challenge 2: Absent an industrial policy 30 years after economic reforms => weak manfg

- **Manfg growth slow: was 17%, now 15% of GDP. 2ndly, Industrial policy before 1980 never utilized India's most abundant factor of production: labour – unlike Easia – moving to cap-intensive manfg & exports**
- **Since 1991, GOI assumed that opening economy, liberalizing/delicensing industry, would alone lead to manufacturing driving growth; it did not. By contrast East/South east Asia had an Industrial Policy & An Educ/skills policy aligned toInd**
- **Learning from Korea and Taiwan, the flow runs sequentially from industrial dev to industrial inhouse R&D to public scientific research. An industrial sector competing with best firms in sophisticated industrial sectors is a requirement for sustaining investment in in-house R&D, => sustaining inv in public scientific res of value to indy**
- **In the last 20 yrs India fell in its share in publications as Korea and Taiwan have invested more in public research (in universities) based on lead in ind technology.**
- **RESULT: Industrial R&D lags is this absence of several sectors that are R&D intensive.**


18
16
14
12
10
8
6
4
2
0
1993
2012
2018
% Manfg in GDP
% Manfg in Emp

Components of industrial policy for manfg growth to enable technological innovation

- **Trade policy needed that complements industrial policy: Correct Inverted duty structure, which allowed capital- & import-intensity of Indian manfg to rise – thus not using India's abundant factor labour;**
- **MSMES in Lab intensive sectors face 2 probs: A. too fast reduction in tariffs, 150% to 10% ave tariffs) precluded protected domestic firms from upgrading technology. B. Small firms' product reservation shd have ended earlier: exposed to intl before dom competition!. Labour intensive manfg needs packages (textiles, garments, leather, wood/furniture, food processing)**
- **Cluster approach needed to support MSMEs – technology upgrade, designs, marketing, credit (77% of credit goes to large firms)**
- **Aligning urban development with manfg cluster locations**
- **Creating a design & innovation institutional system: industrial policy needs a design ecosystem. (Design labs that can contribute to create digital ecocystem. Design labs work to design quality products, carry out digitization, connect electronic systems, innovate for automation – all needed if India is to adapt & develop Indy 4.0 tech)**

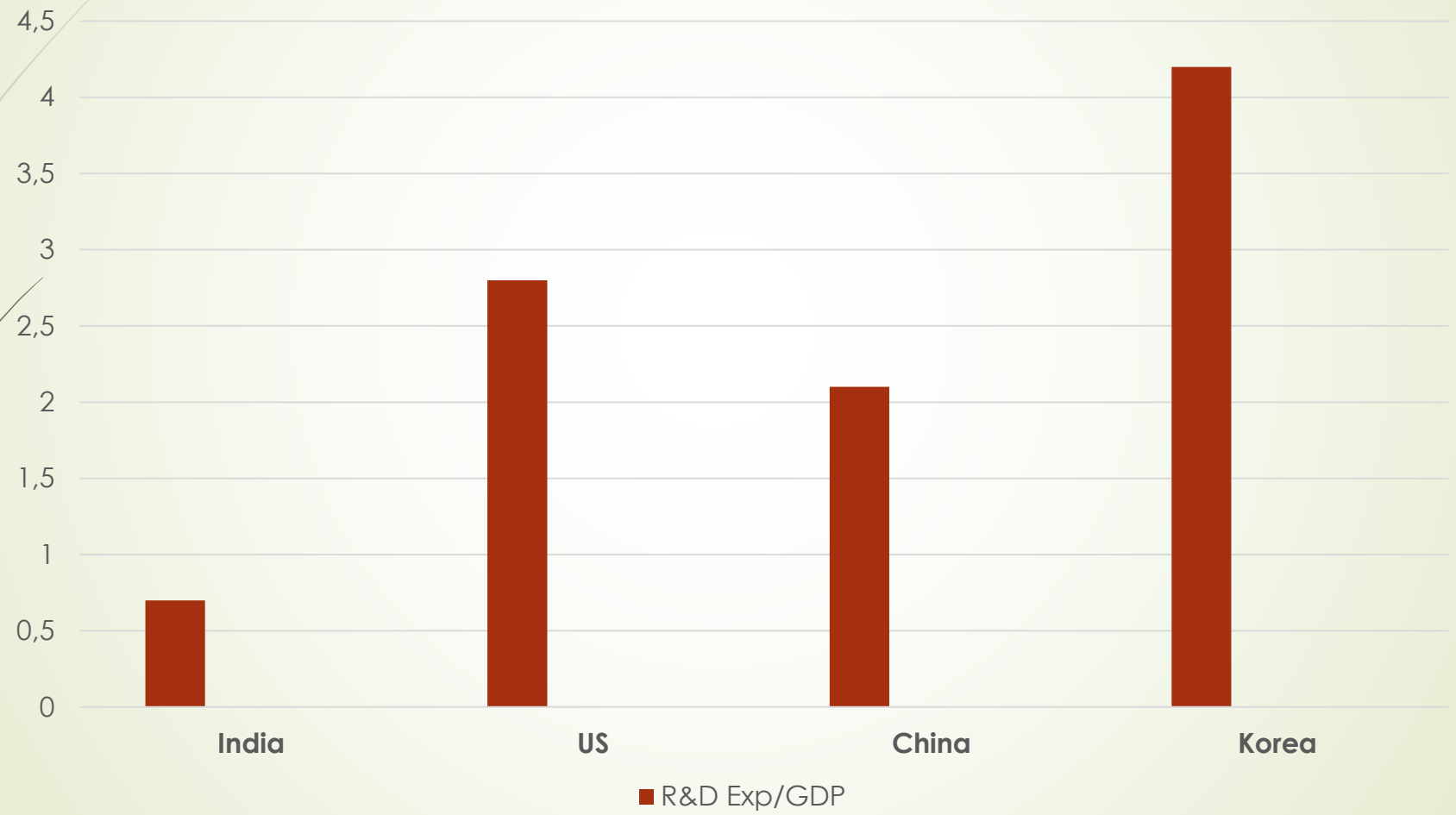
Build *Design* Capacity at enterprise level & *R &D for a National Innovation System*

- Recognize that Importing least expensive inputs a sector needs short-sighted; alternative: technological depth, by investing in design capacity – 'learning by doing' (Stiglitz)
- 'Technology' in most products is under the skin, inside assembled products; even deeper in machines and tools that make the part:
- Reversing negative ERPs and IDS not sufficient; but nor is Protection wise
- We suggest: design and technology frontiers distinct, and that pushing out design frontier was an attractive way of adding value in products without risk involved in pushing out technology frontier: let the world's rich firms make the expensive mistakes. But building design leadership takes serious investment in skills and building R&D competences that few Indian firms have today.
- Incentivise design capacity bldg.:; 1. Use India's Market size as a incentive to force design indigenisation at FDI contract negotiation stage, not just dom input sourcing ; 2. Build Macrolevel learning plans for sectors; 3. Corporates need to incentivise Enterprise leadership

Challenge 3: R & D spending Plus translating ideas into solutions…Public sector problems

- **India spends only 0.82% on R & D, but impressive growth in scientific publications (5th in world) – science; patents filed - technology(12th)**
- **BUT: India's spending is well below that of competition. As a LMIC, India's spending on R&D lags UMICs. But it currently underspends even relative to its income level.**

Share of R&D in GDP



Problems in the Public R&D system

- **Govt spending on R&D is almost entirely by central government. Need for greater State Govt spending, especially application oriented R&D aimed at their specific problems**
- **Severe backlog and high rate of pendency for domestic patent applications. manpower shortages - In 2016-2017, there were only 132 examiners for all India's patent applications. Granting can take 5 or more years => technological obsolescence. Hiring 450 additional patent examiners expedited filing system for Indian residents in 2017**

…requires an innovation system that converts s&t research into innovations in society

- **Increasing R &D exp) will not enough: challenge is to transform it into commercially attractive solutions thru entrepreneurial communities**
- **90% of proposals do not clear initial peer-review evaluations for lack of novelty & poor translational potential;**
- **2ndly, knowledge from supported grants does not pass translational value filters; most patents rarely get used**
- **Result: govt efforts to provide downstream support like setting up technology parks, incubators & incentives for start-ups don't yield results**

Levers for improving outcomes of Indian sti system?

- **Science becoming more multi-disclinary: hence collegium needed in Indian public institutions for inter-disciplinary screening of grants. Collegium shd be supported by EXTERNAL experts in patent-informatics, product profiling & market intelligence**
- **Res grant proposals must pass thru such a filter when institutional level support is sought: Peer-review of govt funding agencies must engage user organizations, patent attorneys, market expert, potential investors**
- **Scientists can speed up translational projects by outsourcing device fabrication or proto-typing to external bodies (perhaps pvt-pub ones)**

Converting research into innovations

- **Institutions face resource constraints to procure & maintain mega facilities: these shd be made available by govt-supported start-up companies located in a cluster of institutions and managed by trained scientists**
- **Scientists will have to wean themselves away from dependence on publications to pick up scientific questions and instead think of research problems that have local relevance**
- **Setting up startups in rural areas with active link to research institutions will allow user-driven product customisation & making innovation policy truly inclusive**
- **Administrative flexibility is required in univs/res/tech institutions to promote creation of start up companies by principal investigators. They shd be allowed to take unpaid leave to initiate startup companies; innovation effort shd be a indicator for academic promotion**

Universities neglected, while Res Inst spend most public R&D Funds

- Publicly funded research in India concentrates in specialized research institutes under government departments. This leaves universities to largely play a teaching role – practice goes back to the 1950s

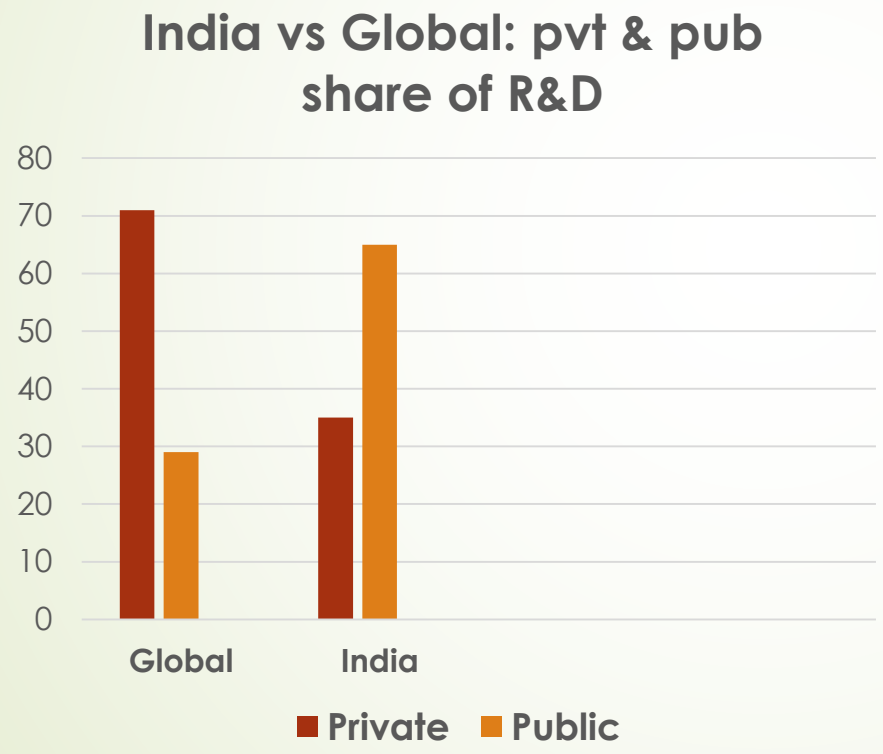
- Naushad Forbes: "the Council of Scientific and Industrial Research encompasses 37 laboratories employing 4000 scientists: assessments of CSIR's contribution to Indian industry (its reason for existence) have shown little connection with industry". We could at least grandfather the problem and allocate incremental public research funding to the higher education sector

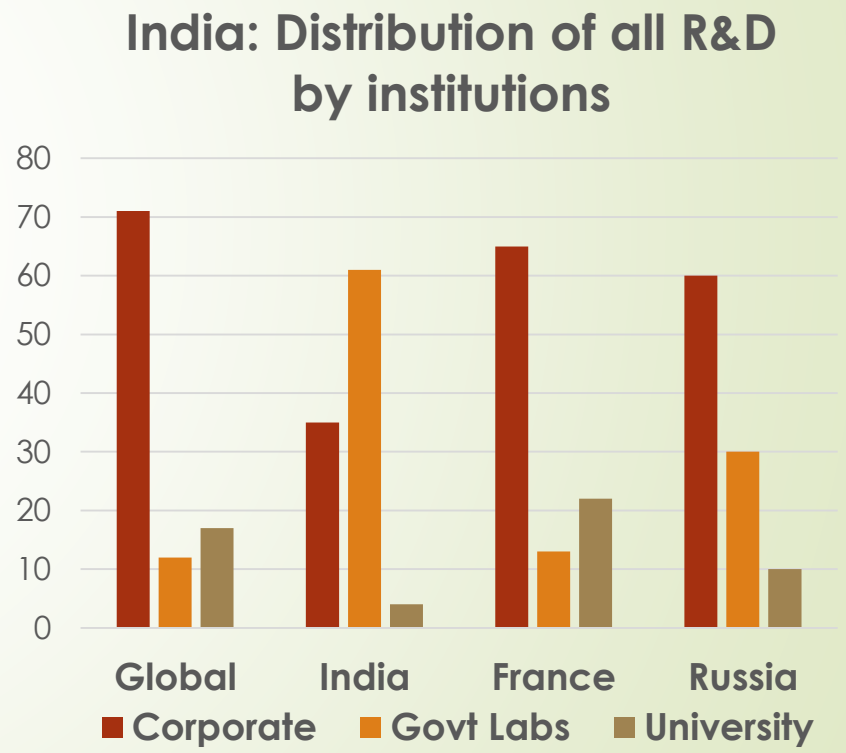
Challenge 4: Innovation & Private/Corporate R & D

- Innovation largely happens in firms globally (71% of it; balance in public inst)

- Private inhouse research has severely lagged public investments
  - there are 26 Indian companies in list of top 2,500 global R&D spenders compared to 301 Chinese companies. 19 (of these 26) firms in only 3 sectors: pharma, auto & software.

Pvt corp share low in total R&D; Pub share dominated by govt labs, not Univ





Way forward to enhance corporate R&D?

- East Asia? SKorea saw two transformations from 1970 to 1990. Industrial share of total R&D rose from 13% of national R&D exp to 81%, when R&D rose from 0.4% of GDP to 1.9%, when GDP grew S Korea at 8% a year. Same China .
- How industrial R&D growth happen? Double source. First, S Korea & China saw substantial structural change in lead industries. Textiles & apparel and food processing (low R&D intensity sectors) - their share in indl output fall.
  - Autos, semiconductors, electronics and IT hardware (high R&D intensity) saw share rise. In India, autos are only R&D intensive sector
- Second, within indl sectors, S Korea and China invested more in R&D: esp semiconductors. A deepening of technical capability within sectors. R&D spending at a few giant R&D spending firms. Emergence of firms like Samsung (at $ 15.3 B, close to India's total investment in R&D) and Huawei (at $ 6.6 B, higher than India's total indl invt in R&D). Shows impact of a few large firms
- Too small to invest in R&D? Our 10 largest pharma, IT, chemical, & engg firms have a turnover of >$ 500 m – above threshold level. Are Indian firms not profitable enough? Ave corporate profitability (a Return on Sales of 10%) compares well VS China, S Korea.

Way forward: Natl Innovation System

- **1. Higher R&D;**
- **2. More by pvt corp;**
- **3. Govt exp more thru Univ;**
- **4. Govt examine res from translational perspective: not provide downstream support (technology parks, incubators, incentives for start-ups) without NIS systems thinking**

India & OECD STI Policy 2021

- **INDIA STI POLICY: To ensure systematic governance of the expanded STI financing landscape, an STI Development Bank will be set up to facilitate a corpus fund for investing in direct long term investments in select strategic areas on various long and medium-term projects, commercial ventures, start-ups, technology diffusion and licensing etc.**
- **Engagement with the Diaspora will be intensified through attracting the best talent back home through fellowships, internships schemes and research opportunities expanded. Appropriate facilitating channels will be created for remote contribution as well. An engagement portal exclusively for the Indian scientific diaspora will be created**
- **OECD STI 2021: "the current crisis serves as a reminder that policy needs to be able to guide innovation efforts to where they are most needed. This has implications for how governments support research and innovation in firms, which account for about 70% of R&D expenditures in the OECD.**
- **The business R&D support policy mix has shifted in recent decades towards a greater reliance on tax compared to direct support instruments such as contracts, grants or awards. While effective for incentivising businesses to innovate, R&D tax incentives are indirect, untargeted and tend to generate incremental innovations. "**
  - **Well-designed direct measures for R&D are potentially better suited to supporting longer-term, high-risk research, and targeting innovations that either generate public goods (e.g. in health)**