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India's Next Challenge – World Class Research Universities to Spur R&D Intensive High Technology Industries

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India's economy has shown sustained growth for the past two decades and is now broad based and spread across a variety of goods and services. Auto and Pharma manufacturing are doing well, and we have a vibrant services sector in software, finance and telecom, and more recently, a fast-growing e-commerce and fintech industry. With a USD 2.6 trillion GDP, we are the world's sixth largest (third largest in Purchasing Power Parity terms) economy.

India needs rapid economic growth to lift our per capita GDP from its current level of around USD 2,000 to reach USD 10,000 in a few decades . In today's world, economic growth is increasingly underpinned by technology enabled services and manufacturing sectors. We can divide these areas into two layers. The first, medium technology, but GDP-wise a larger layer, includes service sectors (e.g., telecom networks, e-commerce) and manufacturing sectors (auto, machine tools). The other layer is the R&D Intensive (RDI) high technology manufacturing industries such as computer systems, telecom equipment, and semiconductors (often called core infotech), advanced instrumentation, commercial aircraft, and patented (branded) pharmaceuticals.

The RDI industry sector is growing in its reach as more of manufacturing becomes R&D intensive. For example, self-driving cars now need advanced computing and sensor technology, transforming a medium tech auto sector into a high tech one. The US share of the global RDI sector is about 31% and China's is 22 %, while India's current share is negligible. The RDI sector is extremely difficult to enter, thanks to huge R&D investments and the high skill sets that are needed. It is also important to note that the RDI segment is globally intertwined, and no nation is self-sufficient. Even the ubiquitous smart phone, uses technologies sourced from about a dozen countries. India's goal, therefore, must be to become a significant (say 5%) global market share participant in this sector within the next two decades. To achieve that, we need clarity of vision, perseverance and fundamental changes.

The key to building the RDI industry is a Triple Helix partnership of Industry, Research Universities, and the Government. The triple helix metaphor captures the close interdependence of three components and the resulting rise in public good. The first helix is the Government, which has a cornerstone role through policy support and investments. Policies may include visionary focus and prioritisation of frontier technologies, measures to attract global talent and capital investments, a R&D friendly taxation, among many others. The government must also invest in city scale physical

infrastructure for high tech industries and increase funding for both public and private sector research institutions which can serve this sector.

The second helix is Research Universities. India needs world class research universities whose innovation and entrepreneurship can fuel RDI industries. An extreme example is Stanford University whose alumni and faculty have created nearly 40,000 companies that generate around USD \$2.7 trillion in annual revenues. The Industry and Research University partnerships, like Stanford University – Silicon Valley and Tsinghua University – Zhongguancun Science Park, are great success stories. They are also a testament to the government's role in promoting a high technology eco-system.

And the third helix is the RDI industry itself. These companies are best built in the private sector. Creating such an industry faces massive barriers and will take decades of investment. To succeed, it needs the other two helices to be firmly in place - government support predicated on a thorough knowledge of the RDI sector, and world class research universities that can partner with this sector.

What is India's status in research universities? No doubt India had a knowledge tradition in ancient times going back to Nalanda. Today, our premier education institutions generate well trained MS/BS level manpower for domestic and global corporations. However, our universities are not at the levels needed to spur RDI industries. University rankings are a measure of this potential. If we consider IISc., Bangalore, our top research university, it ranks 177 in the QS World University Rankings and 401-500 in ARWU (Academic Rankings of World Universities). No doubt universities in advanced economies with a long tradition of research excellence dominate global rankings. On the other hand, China, which began to focus on research universities only from the early '80s, now has seven in top 100, and over 50 in top 500.

India needs preeminent research universities to build an advanced technology economy. It's a prerequisite for such an aspiration. Perhaps an ambitious goal for the country can be five research universities in top 100 rankings within next 25-40 years. We will soon be the most populous nation in the world and our growing GDP can generate resources to invest in this goal.

A promising path to creating top research universities in India is to build them in the private sector. What does it take to build such research universities? One, they need the autonomy and flexibility to compete for and attract exceptional international researchers to build important new research disciplines. Two, they need to nurture innovation and entrepreneurship with close links to best global eco-systems. Three, they will need state / central governments to enact favorable regulations, designed to meet the unique needs of such apex institutions. And four, they must also be able to compete on an equal footing with public universities for government research contracts and grants.

Most importantly, to succeed, such research universities will need to attract very large endowments, perhaps in the range of over a billion US dollars and support financial models to be able to compete with top tier universities. To this end, they need to be backed by philanthropic generosity of visionary Indians with great wealth who appreciate and understand that top research universities will be truly India's most important assets. No doubt this will take decades of support and perseverance, but this is also how today's leading research universities in the world were built. In the US, the support of private philanthropists such as Leland and Jane Stanford, Andrew Carnegie, and John Harvard, seeded great universities leaving a valuable legacy. In India, support of kings and local community helped build and sustain institutions such as Nalanda more than a millennia ago.

The next few decades are going to be critical in high end technologies like Semiconductors, Artificial Intelligence, Computing and Telecom, Energy and Battery, Commercial Aircraft, Space, Pharmaceuticals, and frontier technologies exploiting Genetics, Quantum Physics, Cognitive and Brain Sciences. Our gap in these technologies is growing exponentially and our vulnerability is made worse by the new threats of technology denial even in commercial sectors, holding hostage entire segments of a nation's economy. To resist technology colonisation, India needs to become a producer of high end and frontier technologies, as well as become a major research hub; rather than remain an importer and consumer of such technologies. Building world class research universities, as we have argued, is not an option but an urgent national imperative for India. It is critical for our national security, our economic prosperity, and our societal well-being.

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