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Mobile manufacturing path for India: Lessons from other Asian countries

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Abstract

For almost two decades now Government of India has tried out numerous policies for establishing mobile manufacturing in the country. Though mobile production facilities started their operations in India in 2005, studies have shown that it is only low value assembly that is carried out in the country. In this paper, we infer a few policy lessons for India from the experiences of four Asian countries – South Korea, Taiwan, China, and Vietnam – that have walked down this path. We argue that for India to attain its goal, increasing public investment in mobile technology research will help. Our paper suggests that government should incentivise local firms to establish linkages with mobile manufacturing multinational firms. To capture more value, domestic firms that manufacture mobiles need to focus on R&D, marketing and branding activities.

Keywords: Mobile manufacturing, Industrial policy, India, China, Vietnam, South Korea

JEL Classification: L96, N65, O38, O25, O53

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1. Introduction

Being the second largest populated country in the world, it is natural that India is among the largest mobile markets globally (ICEA, 2019). Since there is very little electronics manufacturing in the country, a booming mobile market implies huge imports of electronic components – for example, the import share of electronic goods was 12% in 2021-22. Thus, electronics and in particular mobile phone manufacturing provides an opportunity to increase the manufacturing activity in the country.

To this end the Indian government has come up with numerous policies for the sector, which are reflective of the industrial policy pursued by the government. As a part of the 'Make in India' (MiI) policy for mobile manufacturing, in 2015-16, the Indian government implemented the Phased Manufacturing Programme (PMP). It can be argued that production or assembly of mobile phones in India zoomed up due to the PMP, from US $8.2 billion in 2015-16 to US$ 25.9 billion in 2018-19; imports have decreased, and exports of mobile phones are up. However, imports of key components used in the production of mobile phones have also increased during this period. This is because of the strategies followed by global mobile phone firms where they carry out their core activities in their home countries (Dedrick and Kraemer, 2017).

Another recent policy measure is the Production Linked Incentive Scheme (PLI). Using PLI, the government wants to create capacity and an ecosystem for mobile manufacturing in the country. It is an open question as to whether the policy measures announced till now by the Indian government will help it in developing the mobile phone manufacturing sector.

To answer this question, as well as to outline a few choices India can take in this sector, we first explain the evolution of mobile manufacturing along with the different paths taken by various countries that lead in the manufacturing of mobiles (section 2). We then focus on the policies implemented by the Indian government, and the impact of these policies (section 3). Section 4 of the paper concludes with some observations and a few choices that India can make for the development of this sector. At this stage, it may be appropriate to point out that the aim of this paper is not to lay out a detailed road map, but rather to point out a few options that may be available for India, given the policies it has implemented so far.

2 International mobile manufacturing

Mobile phone production, like many other industries, shifted from advanced industrial countries to developing economies. Lee and Gereffi (2013) argue that between 2001 to 2011, the shifting of the production process as well as rise of global value chains (GVC) resulted in a few countries consolidating their share in global exports of mobile phones, which implied consolidation of production in those countries. For example, in 2001, developed countries such as Germany, the UK, South Korea, the US, and Finland dominated mobile phone exports. By 2011, however, 61% of the total exports came from China, South Korea, and Hong Kong (Lee and Gereffi, 2013).

The dominant position of these countries in mobile phone exports has continued ever since. Simultaneously, in addition to shift in production, the mobile phone industry also witnessed shift in composition of its users. People in low- or middle-income countries took to using mobile phones, which implied a drop in prices and tremendous market expansion. Policies of individual countries, especially on the production side, also helped in hastening this process; in particular, policies adopted by China, Taiwan, and South Korea have made an impact on the global production of mobile phones. Recently, even Vietnam has emerged a mobile phone manufacturing destination.

2.1 South Korean manufacturing

Hobday (1995) notes that, in the late 1980s, much of the South Korean electronic output was low-quality and low-cost products. In their quest to move towards telecommunications, South Korean firms a) increased their R&D spending, focusing primarily on improving manufacturing technology and market development; b) acquired high-technology firms in other countries; and c) formed technology partnerships with leading foreign companies.

These firms' research hardly focussed on producing new products or knowledge additions through basic research in the field of electronics. Human capabilities in electronics and telecommunication in South Korea was supported by the 'time division exchange national R&D project' that lasted from 1979 till 1991 (Park, 2013). In the early 1990s, when South Korea wanted to enter mobile manufacturing, leading US and European firms were reluctant in transferring technology. To get a foothold in the industry, Korea avoided adopting the popular time division multiple access (TDMA) technologies and embraced code division multiple access (CDMA) technology (Lee et al 2016).

More than 50% of the money made available for CDMA development came from government, with the remaining coming from manufacturers and telecom service providers. A government-run electronics and telecommunications research institute (ETRI), along with Qualcomm, was mainly responsible for developing the CDMA system. Manufacturers were in charge of commercializing the CDMA system, while the service providers had to buy these systems to set up the service infrastructure. An R&D community consisting of all these stakeholders was instrumental in the successful fruition of the development effort (Park, 2013).

The government protected local producers[1] in the domestic market from competition with global brands[2] by awarding CDMA-only mobile service licenses. An innovative way of financing ensured that the cost of developing domestic capabilities was shared in some parts by the mobile service operators as well as final consumers. Park (2013) notes that this first-in-the-world CDMA system utilized spectrum-hopping technology to amplify capacity.

By September 1999, Korea had exported 90 billion won worth of systems, and 1.5 trillion won worth of mobile handsets. Thus, a secured home market not only helped South Korean firms focus on CDMA phones exports[3] to a wide range of markets, but also allowed them to build up domestic capabilities, because of which they were later able to quickly learn and assimilate GSM technology [a].

Lee *et al* (2016) note that export orientation led to a globalised production strategy for South Korea's leading firms; for example, in 2011, more than three-quarters of phones were produced in China and Vietnam. Leading firms also invested in R&D capabilities abroad, which helped them assimilate advanced technology and market trends. Further, leading South Korean producers are also highly vertically integrated. Lee *et al* (2016) note that in 2011, LG outsourced only 13% of its mobile phone production, and Samsung produced its mobile phones in-house[4]. Samsung and LG source many of the key components from their related companies[b] (Lee *et al*, 2016).

2.2 Taiwanese manufacturing

Taiwanese firms entered mobile manufacturing in the 1990s, primarily as suppliers – many started as producers of cases for keypads. Later, some of these firms started assembling mobile phones according to the designs and specifications of buyers. With time, some firms accumulated capabilities in scale and technology to provide electronic manufacturing service (EMS). These firms specialised in supply chain management and large-scale manufacturing for global brands. A few others developed product design capability, becoming original design manufacturers (ODMs) to capture the design to assembly value chain.

In the early 2000s, when the focus was on outsourcing, these firms helped the growth in Taiwan's exports of mobile phones. The remaining firms in the Taiwan ecosystem relied on their strong R&D competency to focus on a variety of high value-added components. Thus, Taiwan rose successfully as a specialized supply base, while South Korea was successful in nurturing global brands (Lee *et al*, 2016).

2.3 Chinese manufacturing

In its aim to enter mobile manufacturing, China has followed multiple paths (Lee *et al* 2016).

First, in the late 1980s, for multinational corporations (MNC), the Chinese government linked domestic market access and technology transfer, with the hope for spillover effects (Zhao *et al*, 2007).

Second, the Chinese government used industrial policy to shield and nurture domestic firms (Imai & Shiu, 2007; Zhao *et al*, 2007). Though imports of finished handsets were strictly controlled, until the late 1990s mobile phone production was dominated by foreign firms, which set up joint ventures with state-owned telecommunication equipment makers. As the literature would predict, these joint ventures assembled components, because of which local partners did not acquire much technological capability. However, by 1999, licenses were made mandatory for the production, expansion of production, and marketing of mobiles. For foreign joint ventures regulations such as minimum export ratio and local content requirements were imposed (Imai & Shiu, 2007).

Since the chances of getting a license were slim, many Taiwanese ODMs joined forces with local firms that already had obtained a license. These policy measures helped China become an important mobile phone manufacturing destination; Brandt & Thun (2011) note that between 1998 and 2009, China increased its share from 2% of global production to approximately 50%, and that most of this

production was for exports. Competition and success[5] in the local market helped local firms to emerge successful in international markets.

Third, to cater to its huge domestic market, the Chinese government worked with domestic and foreign firms to develop an indigenous 3G standard[6], which was then licensed to the largest mobile network operator (China Mobile). Brandt and Thun (2011) emphasize that the domestic standard forced MNCs to adapt. If firms wanted to do business with China Mobile, they were forced to develop entirely new products, rather than introduce global products with slight changes in the user interface.

The benefit of this adaptation was that much of the design and engineering work that was related to the standard was done in China, both within internal R&D units and external independent design houses (IDHs), which helped establish an ecosystem in China. Lee *et al*(2016) point out that existence of a huge domestic market increased the adoption of home-grown standards, which incentivised MNCs to come up with handsets for these standards. Finally, it is important to infer that with the investments to build its own standard, China also built up its capability to absorb and assimilate various technologies[7].

2.4 Vietnamese manufacturing

Recently, Vietnam has integrated itself into the mobile phones GVC. The World Bank argues that it is a success (WDR, 2020). Vietnamese policy primarily included offering huge financial and tax incentives to firms, because of which renowned global manufacturers have set up facilities in Vietnam. As per UN Comtrade data, Vietnam's exports of mobiles have zoomed from US$ 1.6 billion in 2010 to US $ 33.6 billion in 2021. We review the Vietnamese experience in detail in section 4.

To summarize, all the four countries mentioned above have made a mark for themselves in the mobile manufacturing segment. South Korea and Taiwan have built capabilities which make them a formidable participant in the ecosystem. As we will discuss later, China and Vietnam are yet to build these capabilities. If India is indeed serious about being a global player in this segment, then focusing on capabilities is critical. In the next section, we summarize the production and trade policies in India that are relevant for building capability in mobile manufacturing.

3 Indian Policies for Mobile phone manufacturing and its impact

3.1 Production policies pre-2012

The policy framework that was followed in independent India for electronics manufacturing emphasized self-reliance. High tariffs and quantitative restrictions ensured some local hardware production, which got a further boost in the early 1980s, when policy allowed for duty-free import of capital goods and lower duty on components. Financial benefits as well as relaxations of labour and environmental laws were used to encourage local production.

Francis (2016) points out that policy did not link local hardware production with the growth in software exports[8], thereby losing an opportunity for capability development. This linking could have increased the productivity of existing hardware manufacturers. The government also did not build on the R&D capabilities India had built in developing digital switching equipment (Mani, 2005). Simultaneously, lack of capability development policies in the consumer electronics industry was apparent, and cost us dearly (Francis, 2016).

3.2 Trade policies

India joined the Information Technology Agreement (ITA-1) in 1997, when as per Ernst (2014) its electronics sector was initializing. As per ITA-1, each signatory was bound to eliminate customs duties, other duties, and charges of any kind on the trade of information technology products. Ernst (2014) highlights that India's entry into ITA-1 not only drastically reduced chances of improving domestic capabilities, but also discouraged investors from scaling such capabilities in India[c]. Excessive speed in the implementation of tariff reductions and the resultant jump in imports decimated local production (Francis, 2018). Export and import figures from headphones and ear phones sub-segment[9] of the telecommunications segment makes this point amply clear.

In addition, the ASEAN, Japan, and South Korea free trade agreements (FTAs) opened tariff lines that were not covered in ITA-1, which added on to the impact. Policymakers hoped that India's integration into electronic GVCs would be expedited by these FTAs, which did not happen (Francis, 2018). Indian experience with its liberal foreign direct investment (FDI) regime since 1991 in the electronics sector confirms the literature's expectations, i.e., large MNCs set up only final assembly plants, increasing import dependence without creating domestic backward linkages[d] (Ernst, 2014; Saripalle, 2015, Rajakumar, 2014; Verma, 2015, Francis, 2016).

Table 1: Export and import of Headphones Earphones and Combined Microphone or Speaker Sets (HS85183000) in US $ million

Fiscal Year	Exports	Imports	E-I
1997	0.090	0.600	-0.510
1998	0.140	1.920	-1.780
1999	0.330	1.920	-1.590
2000	1.040	1.980	-0.940
2001	0.510	2.680	-2.170
2002	0.570	4.560	-3.990
2003	0.420	10.000	-9.580
2004	0.140	8.580	-8.440
2005	0.090	11.460	-11.370
2006	0.140	15.110	-14.970
2007	0.130	22.710	-22.580
2008	0.350	33.000	-32.650
2009	0.570	89.940	-89.370
2010	4.210	60.470	-56.260
2011	0.120	78.990	-78.870
2012	0.770	191.950	-191.180
2013	0.460	218.240	-217.780
2014	0.770	172.410	-171.640
2015	1.610	117.250	-115.640
2016	1.180	137.830	-136.650
2017	1.690	192.080	-190.390
2018	2.850	242.630	-239.780
2019	9.880	282.490	-272.610

Note: 1997 implies April 96- March 97.

Source: CEIC database

3.3 Production policies post 2012

The decimation of local hardware production in electronics prompted Indian policy makers to come up with the National Policy on Electronics (NPE) 2012.

- One of the policy initiatives in this regard has been the Modified Special Incentive Package scheme (M-SIPS), under which mobile units enjoyed capex benefits.
- In addition, 100% FDI is permitted for the mobile manufacturing ecosystem. Export incentives were made available under the Merchandise Export from India Scheme (MEIS)[10], and duty-free imports of specified capital goods were permitted.

- Units in special economic zones (SEZ) can avail tax benefits, both at the central and state/provincial level.
- Provincial or state governments have also announced competitive incentives on taxes, land, and inputs.
- The PMP[11] - policy that discourages imports by imposing higher tariffs - implemented by the central government encourages local manufacture or assembly of low-value (followed by higher-value) components (Table 2).

Table 2: PMP – mobile phones

Year	Sub-Assembly	Duty Structure under PMP
2016-17	Charger/ Adapter, Battery Pack, Wired Headset	15 % (Implemented)
2017-18	Mechanics, Die Cut Parts, Microphone and Receiver, Key Pad, USB Cable	15 % (Implemented)
2018-19	Printed Circuit Board Assembly (PCBA), Camera Module, Connectors	10% (Implemented)
2019-20	Display Assembly, Touch Panel/ Cover Glass Assembly, Vibrator Motor / Ringer	Likely to be deferred

Source: Ministry of Electronics and Information Technology, Government of India; Mani (2019)

In April 2020, mobile production was among the first sectors for which the government implemented PLI, another incentive-based scheme, on incremental sales over FY20 for a period of five years. Firms desiring the incentive had to apply for the PLI scheme, and a few domestic and foreign firms were selected.

Incentive disbursement under PLI is subject to meeting incremental investment thresholds and incremental mobile phone sales targets; foreign and domestic mobile firms have different thresholds. For example, incremental investments over four years for domestic and foreign firms are Rs. 200 crores and Rs. 1,000 crores respectively. Similarly, the thresholds for incremental mobile sales vary for domestic and foreign firms. Incentives under PLI were supposed to be applicable from August 2020. To summarize, for mobile manufacturing, in addition to the general central and state-level industrial incentives, we have the PMP and PLI that are applicable as well.

3.4 Indian mobile manufacturing scenario

Mobile phone production in India began in 2005, when there were a series of investments in manufacturing facilities by OEMs (LG, Nokia, and Samsung) and EMS (Elcoteq and Flexotronics) firms. Table 3 presents the production, imports and exports of mobile phones, and imports of parts of mobile phones over the years.

Table 3: Production, Imports and Exports of Mobile Phones and its parts in US $billion

Year	Production (MP)	Imports (MP)	Exports (MP)	Imports of PCB	Imports of Other parts
2009-10	6.5	3.23	1.28	0.138	1.842
2010-11	7.8	5.47	2.62	0.138	2.961
2011-12	8.5	5.82	2.73	0.128	2.555
2012-13	8.5	4.75	2.66	0.122	2.783
2013-14	4.4	5.93	1.95	0.105	2.568
2014-15	3.1	7.95	0.26	0.197	2.642
2015-16	8.2	6.06	0.22	0.542	4.497
2016-17	13.4	3.79	0.17	1.181	6.259
2017-18	20.5	3.54	0.21	4.856	6.707
2018-19	24.3	1.62	1.61	2.121	6.592
2019-20	31.7	1.04	3.84	0.699	7.225
2020-21	30	2.23	3.07	0.537	6.445
2021-22	38	1.49	4.58	0.533	7.401
2022-23	--**	0.033	0.042*	--	--

MP: Mobile phones; PCB: Printed circuit boards; Other parts: Mobile phone parts; NA: Not available.

*- Ikdhvaj & ICEA (2023) puts this at US $ 11.1 billion

**- Ikdhvaj & ICEA (2023) puts this at US $ 44 billion.

Source: Ministry of Commerce and Industry, Government of India for imports and exports; various annual reports of Ministry of Electronics & Information Technology, Government of India for production.

Wilde & Haan (2006) observe that, in 2005, companies imported a majority of their raw materials (75-90% of total inputs), and firms were engaged largely in labour-intensive, low-technology assembly work, with very little value addition. The closing of the Nokia facility at Sriperumbudur led to a drastic decline in production and surge in imports of mobile phones in 2014-15.

There has been some impact of the NPE combined with PMP policy, as production of mobile phones in the country has increased, imports of mobile phones have reduced, and exports are on the rise[12]. PMP implementation has also ensured that electronic components are imported and used for assembling mobile phones in the country. For PCB imports, the drastic increase in FY 18, drop in FY 19, and further steep drop in FY 20 can be attributed to the PMP for PCB that came into effect in FY 19.

Imports of other parts of mobile phones continue to increase. Increasing production in the past few years has been due to investments in final assembling facilities for mobile phones. These investments have been primarily due to the establishment of facilities by foreign firms, whose market share has also increased commensurately during this period. For example, in the second quarter of 2018, foreign brands such as Xiaomi, Samsung, Vivo, and Oppo together had a market share of 73.8%

of the Indian smartphone market (ICEA, 2019). To offset the exchange rate risk, especially when the rupee becomes weak[13], and take advantage of MiI and PMP policies to consolidate their position in the country, these brands have been investing in manufacturing or assembling facilities in India.

The increasing market share of foreign brands has been at the expense of Indian brands, which dominated the Indian market till FY 15. Indian mobile firms, which generally operate at a much lower scale than foreign firms, now account for a very low share of the Indian market. Additionally, the huge imports of PCBs and other mobile parts point to the lack of a component ecosystem in the country. Most of the components continue to be imported, despite the rise in basic customs duty[14] after implementation of the PMP.

Dependence on imported raw materials

After the macro picture, it may be useful to look at firm level data. For this, we pick up units from National Industrial Classification (NIC) code 26305 [Manufacture of pagers, cellular phones and other mobile communication equipment] that were reported in the Annual Survey of Industries[15] (ASI), published by the Ministry of Statistics and Programme Implementation, Government of India (2016-17 and 2017-18 data). Firms at the five-digit classification level buy inputs from domestic as well as foreign sources.

Table 4 shows the details for 2016-17 and 2017-18 for mobile producing units only. To make the analysis size independent, we present the ratio of raw materials in the total cost of production.

Table 4: NIC 26305 units – raw materials share of total cost of production

2016-17			2017-18		
Unit	Local	Import	Unit	Local	Import
1	0.003	0.953	1	0.023	0.936
2	0.949	--	2	0.922	--
4	0.002	0.946	3	0.112	0.845
6	0.032	0.908	5	0.110	0.866
7	0.013	0.937	10	0.058	0.426
9	0.036	0.011	11	0.931	--
12	0.003	0.969	12	0.002	0.972
14	0.009	0.813	13	0.003	0.864
			14	0.062	0.908

Source: ASI data for NIC code 26305 for 2016-17 & 2017-18.

For 2016-17 and 2017-18, we find that most of the units rely on imported inputs. Poring through the details of imports, one finds that both for 2016-17 and 2017-18, electronic components dominate. Thus, electronic component manufacturing for mobile production in India is negligible.

(Among locally sourced non-electronic inputs, bulk of the sourcing is for cardboard boxes and packing material!)

This is in line with empirical evidence that MNCs locate core activities in their home countries and set up low-value-add assembly plants in growing markets (Table 5). Lee and Jung (2015) highlight that, though Samsung relocated some segments of value chain abroad, the higher-value segments such as R&D and marketing remained in Korea. Dedrick and Kraemer (2017) find that the share of assembly cost in the total cost of a mobile[16] is among the least. India's experience with the Nokia assembly plant near Chennai has not only demonstrated the fickleness but also shallowness of such assembly investments.

Table 5: Location of activities in the global value chain of the smartphone segment

Activity	R&D, Design, Sourcing	Development &Engg	Manufacture of key components (production)	Final Assembly (production)
Apple	US	US/Taiwan	US/Japan/Korea/ Taiwan/China	China*, India*
Samsung	Korea	Korea	Korea/Japan/US/ China	Korea, Vietnam, China, India, Brazil, Indonesia
Huawei	China	China	China/Korea	China, India

* as of 2017

Source: Dedrick & Kraemer (2017)

Competition from local brands

Domestic firms have been an important part of the mobile phone manufacturing ecosystem in the country. In the early part of the decade, in a fast-growing market, Indian phone makers competed well with foreign firms. Leading the charge was Micromax (Bhagwati Products Ltd.), in some sense the poster boy of the Indian handset industry. Ding and Pan (2011) note that 200 local companies in India, including local brands such as Micromax and Lava, used ODM firms from the Shanzhai system[17] in China to transform from distributors to brand owners. Table 6 below uses available data to substantiate this statement.

As the PMP was implemented, dependence on imported raw materials for Micromax increased from 26% in FY14 to almost 83% in FY17. This is a hint that, before PMP, this firm imported mobile phones in semi-knocked-down kits format and assembled them here; while after PMP it has been importing in completely-knocked-down format. For Lava, as the PMP has been implemented, they have moved from importing finished goods to importing raw materials. It needs to be pointed out that product design for Lava is done from China[18].

Table 6: Performance of selected domestic firms in Rs. million

	Bhagwati Products Ltd.			Lava International Ltd.		
Year	Sales	IRM	IFG	Sales	IRM	IFG
2013-14	3613.3	937.3	--	26992	--	20492.2
2014-15	18290.1	10563.2	--	44881.9	--	35458.4
2015-16	47634	38410.3	--	48120.4	35465.2	--
2016-17	21674.4	17943.6	--	36279.6	23299.7	--
2017-18	21141.6	--	--	32446.2	20831.4	--
2018-19	8534.5	--	3354.9	28913	18186.1	--
2019-20	4528.6	--	3297.5	17899.2	11013.4	--
2020-21	9963.7	--	7719.8	15924.8	--	--
2021-22	13304.9	--	7739	18109.6	--	--
2022-23	9229	--	4992.7	--	--	--

Note: IRM – import of raw materials, IFG – import of finished goods

Source: Prowess, Centre for Monitoring Indian Economy

No wonder that, from a peak of over 45% in 2014, the share of Indian brands fell below 10% in 2018. This was principally because Chinese firms not only outdid Indian firms in the price game, but also turned the competitive dynamics at the lower end of the handset market from price to value. From being fringe players offering inexpensive phones to price-sensitive consumers, Chinese handset firms have risen to corner an unprecedented 60% share of the smartphone market in 2018.

Table 7 shows the recent financial performance of one Chinese firm (Oppo) and of Foxconn or Bharat Fih Ltd. (contract manufacturer for Apple and Xiaomi). The large amounts of imported raw materials indicate assembly for these top-selling brands. Needless to add, increasing market share for Chinese firms has come at the expense of Indian firms, who never developed design and other capabilities, and kept focussing on importing components in knocked-down format and assembling the phones here.

Table 7: Performance of selected foreign firms in Rs. million

	Oppo Mobiles India Pvt. Ltd.		Bharat Fih Ltd.	
Year	Sales	IRM	Sales	IRM
2019-20	385424.3	332485.2	263922.2	--
2020-21	427658.2	--	158197.2	--
2021-22	569407.4	--	181183.4	--
2022-23	516868	--	115776.3	--

Note: IRM – import of raw materials

Source: Prowess, Centre for Monitoring Indian Economy

3.5 Lack of Intellectual Property

Publicly-funded research in electronics has helped India acquire some capability in electronics. For example, in 1984, a public laboratory called Centre for Development of Telematics (C-DOT) was established to conduct research in telecommunications equipment. C-DOT was expected to transfer the technology developed to public and private sector firms. The lab successfully developed a digital switching equipment for smaller rural exchanges; as a result, the market for switching equipments became contestable,[19] eventually leading to reduction in the average price of switching equipments (Mani, 2005). Thus, R&D intervention in the electronics sector has led to benefits to the economy.

India has neglected similar investments in mobile technology, and has not generated any intellectual property in the mobile phone manufacturing space. Mani (2019) notes that almost all the applicants for patents before the Indian Patent Office in mobile communications technologies are from abroad. Indian firms accounted only for 18 patent applications (and not patents) among the thousands of applications and patents that have been filed and awarded. Most of the patents in the next generation mobile technologies (such as 4G and 5G) were held by non-Indian firms, making Indian manufacturing firms dependent on them for the technology (Mani, 2019). In the last few years, there have been attempts by the Indian government to come up with its own 6G standards[20].

To summarize our discussion, if India wants mobile investments to generate livelihoods on a sustained basis and contribute to the revival of manufacturing in the country, then it is important for India to build capabilities, not only by investing in mobile technology research, but also by making itself indispensable in the production plans of MNCs and component manufacturers. We believe that the South Korean example clearly shows that building capabilities is a long-term project, a path that has larger investment commitment with lesser returns in short-run. Given today's multilateral trade context, in the next section we point out a few lessons from the recent Chinese and Vietnamese experience[e] that can be used to formulate policy.

4. Observations and Future Choices

Amsden (1997) points out that governments of late-comer countries have played an important role in industrialization, by joining with the private sector to socially construct competitive assets (resources, capabilities, and organizations) rather than to create perfect markets. However, India being a WTO member has significantly reduced its options for national support policies (Ernst, 2014). It does not help that current policies, such as PMP and PLI, have opposite effects: PMP promotes imports substitution, while PLI promotes exports (Mishra et al, 2022).

Our analysis of the sector makes it clear that mobile manufacture in India is import dependent, with a lack of intellectual property. Import dependence is also reflected in an international comparison in the following table, where the ratio of exports to imports for mobile phone and its parts for China, India, and Vietnam have been put together.

Table 8: Mobile phone and parts - ratio of exports to imports

	Mobile phone			Parts		
Year	China	India	Vietnam	China	India	Vietnam
2009	22.3	1.1	0.3	1.6	0.1	0.5
2010	41.2	0.3	1.7	1.8	0.1	0.3
2011	49.2	0.6	6.3	1.6	0.3	0.2
2012	49.7	0.6	13.6	1.2	0.2	0.5
2013	57.7	0.4	19.6	1.2	0.3	0.2
2014	64.6	0.1	16.5	1.2	0.2	0.3
2015	41.5	0.0	18.0	1.2	0.1	0.5
2016	46.0	0.1	17.1	1.3	0.1	0.8
2017	169.5	0.0	16.0	1.2	0.0	1.0
2018	486.8	0.5	18.6	1.2	0.0	1.2
2019	286.0	3.9	19.4	1.3	0.0	1.3
2020	140.4	1.4	20.7	1.3	0.1	1.3
2021*	111.8	3.2	13.0	1.2	0.1	1.2

Note: * - Latest data available as on 1st May 2024.

Source: UN Comtrade

For the period 2009-2021, for mobile phones, China is miles ahead of India; Vietnam, which was behind India in 2009, overtook India the following year and continues to be much ahead. With respect to parts, it seems that China has been successful in establishing significant component production, as its export-to-import ratio is above one throughout the period. Vietnam was a component importer till 2016; however, post 2016, it seems to have set up some component production facilities, as the ratio has also risen above one. India's failure in component production can be seen from the close-to-zero ratio throughout the period.

This inference is also emphasized in a comparison of the competitiveness index for mobile handsets, computed by CII-NCAER (2022). This leads us to believe that Indian policy makers can probably learn from the Chinese and Vietnamese experience to decide on the path or paths that may help the sector.

Table 9: Competitiveness index for mobile handsets

Country	2018	2019	2020
China	3.64	3.21	2.97
Vietnam	8.19	8.25	6.73
India	`0.22	0.67	0.66

Source: CII-NCAER (2022)

4.1 Lessons from the Chinese experience[f]

As mentioned above, China followed multiple paths to enter mobile manufacturing – linking of domestic market access and technology transfer for MNCs; industrial policy to shield and nurture domestic firms; and investment in indigenous standards.

Brandt and Thun (2011) point out that when handset manufacturing activities first began to shift to China, MNCs were focussed on exports, as the domestic market was negligible. Within a decade, China became the largest market in the globe; however, for a variety of reasons MNC producers did not change their component sourcing strategy for handsets that were sold in China.

- First, other than minor changes in the user interface, the products demanded by the Chinese market and the global market were similar. Economies of scale obtained by ensuring same design of a low-end handset across markets discouraged use of local suppliers.
- Second, modular architecture allowed for changes in the respective modules, without impacting other modules and hence continuance of the same sourcing strategy. Common global platforms allowed Nokia to price below competing OEMs.
- Finally, low transportation costs made imports of small but high value electronic parts and components competitive.

As a result, Xing (2014) finds that in 2009, China's value add was 3% of its exports of iPhones and laptop PCs. This situation, however, seems to be changing, as Chinese local firms seem to be acquiring capabilities, because of which they are now supplying components that go into the production of an Apple phone. To understand the involvement of Chinese firms in its production, Xing (2019) deconstructs the iPhone X.

- Core components embedded in the printed circuit board assembly (PCBA) were being supplied by non-Chinese companies, and Chinese companies supplied only a tiny share of non-core components of the PCBA.
- However, 10 local companies supply parts for component manufacturing, for example, function parts for touchscreen module, filter for 3D sensing module, coil module for wireless charging, PCB, speakers, RF antenna, battery pack, glass cover, stainless frame, and camera module.

The mechanism of capability acquisition for all but one of these firms is not clear; the Chinese firm that supplies PCBs acquired its capability by buying out the American firm that used to supply PCBs for Apple iPhone manufacture[g]. Value addition by Chinese firms that supply components account for 25.4% of the manufacturing costs of iPhoneX, while that as a percentage of the retail price account for 10.4% (Xing, 2019).

The emergence of the Shanzhai cell phone industry not only helped expand the Chinese domestic market, but also saw the rise of Chinese brands (Ding and Pan, 2011). These brands could enter the mobile market primarily due the lowering of technological barriers by Mediatek – a chip maker from Taiwan – which saved new mobile phone makers the high cost of R&D. These local firms took

advantage of the trend of platform-based development in the migration towards smartphones. Using their knowledge of local preferences and needs, these local firms catered to the demand at the lower end of the market and became market leaders.

For example, in 2011, Xiaomi began to sell high-end phones at low prices, using unique and innovative strategies. The company generated revenue through selling apps, and introduced a customised version of Android which had additional functionality. As a result, by 2014, Xiaomi had over taken Samsung to become the leading smartphone vendor in China (Chuang, 2016).

This implies that there is scope for firms from latecomer countries to increase their value addition by focussing on the downstream activities such as branding, marketing etc. It is interesting to note that, while the value added by Chinese firms supplying components accounts for 15.4% of the production cost of a Xiaomi phone, the value addition by Chinese firms increases to 41.7% of the retail price for a Xiaomi phone (Xing, 2019).

4.2 Lessons from the Vietnamese experience

Table 8 showed that Vietnam has overtaken India both in mobiles and parts production; however, literature is divided on its impact on the level and depth of local industrial development in Vietnam.

- Tran and Norlund (2015) mention that integration into global markets has not implied that access to knowledge and technology transfer has become easier, implying that positive spillover effects were absent.
- Local firms provided only labour-intensive assembly of low value components (Ohno, 2009 and Vind, 2008).
- Offering higher salaries, MNCs hired the best talent, weakening the absorptive capacity, and, hence, upgrading of domestic firms (Vind, 2008).
- Many a times, MNC sourcing strategy worked against local linkages, for example, Samsung relied heavily on its Korean suppliers who co-located with it in Vietnam. Four among Samsung's 67 suppliers are local firms, who supply packaging materials (Sturgeon & Zylberberg, 2016).
- Lack of domestic capability will also hinder policy push towards local industrialization. For example, in 2015, the Vietnam Ministry of Industry and Trade announced that Samsung would source simple parts for its mobiles and tablets from local suppliers (Sturgeon & Zylberberg, 2016). While a workshop with 200 local firms was held by Samsung and the Vietnamese government, reportedly, none of the firms were up to the task. Instead of direct local linkages, Samsung planned local linkages for their tier 1 suppliers (Sturgeon & Zylberberg, 2016), which as per table 8, seems to have worked.
- Masina and Cerimele (2018) state that price competition in today's markets does not allow local firms to enter MNCs production networks, as local firms neither have the technology nor the experience to produce quality goods. Moving production to developing countries is

thus a MNC strategy to reduce costs; which implies that late-comer countries face a complex environment to achieve industrial deepening and upgrading (Masina & Cerimele, 2018).

Samsung's mobile phone assembly plant in Vietnam produces 40% of Samsung's global mobile phones (WDR, 2020). However, what WDR (2020) does not point out, but Nakamura and Marukawa (2024) do, is that Samsung procures components from its subsidiaries that have set up plants in Vietnam. A plant to produce cell batteries came up in 2010; camera modules, capacitors, and other components plant started production in 2014; display plant came onstream in 2015. PCBs are produced locally by Korean suppliers of Samsung.

Despite these foreign investments, Nakamura and Marukawa (2024) point out that the share of domestic inputs has gradually declined, and has stagnated at around 35% since 2012, in stark contrast to electronic industries experiences of other major ASEAN nations. They emphasize that low and decreasing domestic value added may be due to manufacture of upgraded products (e.g. smartphones rather than feature phones) at Samsung's facilities. They conclude that local manufacturers can supply only a few parts and packaging materials, as creating domestic backward linkages (composed of highly-integrated capital and technology-intensive components) is not easy, and these important components are unlikely to be manufactured by firms in developing countries because of lack of capabilities. Nakamura and Marukawa (2024) suggest encouraging production of printers rather than production of mobile phones in developing economies such as Vietnam, because they offer more opportunities for local manufacturers to supply parts.

Lee and Jung (2015) point out that Samsung set up a huge factory in Vietnam to benefit from lower costs in the assembly stage of production using local labour. The company claimed that if a phone was produced in Vietnam and not in South Korea, it saved the firm US$5.7 per mobile – which is a huge amount considering the Vietnam production capacity is 120 million units per year. Samsung's internationalization of production has brought a substantial cost reduction, and thus larger profits available for reinvestment.

Another issue in late-comer nations is 'enclave economy', wherein local firms have not been able to integrate into global electronics value chains (Pham *et al*, 2020). As per them, the main barrier preventing linkages of local firms with MNCs is lack of skilled labour. Local firms do not invest in upgrading their technological capability as MNCs encourage local competition, resulting in lower margins. Moreover, MNCs establish local linkages for the incentives they receive from the government, while local firms take on increased risks without government support (Pham et al, 2020). By 2017, 52% of the 600 foreign electronics firms operating in Vietnam were components and part producers. Local firms primarily operated in low-end segments of the value chain (Pham et al, 2020).

4.3 Future choices for India

It has been more than a decade and a half since the first mobile was assembled in India, however, the sector is yet to see any major backward linkage creation. In 2005, Nokia – which ran the largest assembly plant at that time – and its seven supplier companies were expected to usher electronics

hardware manufacturing into the country. Phones and other accessories were assembled using the components imported without duties (Dutta, 2016). The ceasing of operations at the Nokia plant due to a tax dispute alerts us to the fickleness of investments into assembly plants.

In the past eight years, well-known brands such Apple, Xiaomi etc. have started local assembly through their contract manufacturers in India. Though there is not much scholarly literature that has evaluated its impact, it is reasonable to expect a Vietnam kind of experience. The thrust on the PLI emphasizes the belief of the government on export-led industrial development strategy. Among China, Vietnam, and India, however, ICEA & EY (2020) points out that the effective cost of manufacturing mobile phone is cheapest in China, followed by Vietnam, and then India. Thus, Vietnam retains its advantage over India in commodity segments. This implies exports from assembly units with or without PLI will face stiff competition from Vietnam.

Another recent study (Ikdhvaj & ICEA, 2023) compared India's import tariffs in 120 tariff lines for electronics with those in China, Mexico, Thailand, and Vietnam; they found that a larger proportion of imports of the competing economies entered duty free compared to that for India. The study also states that higher Indian tariffs on sub-assemblies and components result in an increase in cost of production in India, which can make going tougher for the assembly units operational in the country. This implies that a cost-competitive manufacturing ecosystem based on government incentives or subsidies alone may not be the best possible path for India. In other words, just relying on PMP plus PLI may not do the job for us.

In addition, it may be useful to point out that although export-led industrial development has been successful in China; it has been criticized as "unsustainable development, low value added, low technology input, labour- and resource-intensive, over dependent on exports and TNCs, and environmentally and socially unsound" (Chuang, 2016).

Iyer (2022) points out that assembly of phones which is at the lowest part of the 'smile' curve[21] is happening in India. This implies that the future path India takes should lead us up either on the right-hand side or left-hand side of the 'smile' curve. Given the policies of PMP plus PLI that we have already implemented, we believe there are at least three policy options that may help India in this journey.

- First, like the Chinese, we need the government to continuously invest in indigenous standards[22] and technologies, which down the road[23] will help build up India's capabilities. These capabilities will help India to strengthen her mobile manufacturing ecosystem, which hopefully, by then, PLI[24] would have built. Adoption of the indigenous standards and technologies in our domestic market has the potential to multiply India's capabilities in the sector.
- Second, literature has shown that modularization, ITA-1, and lower transport costs have hindered the development of domestic backward linkages. The Vietnamese experience is clear: backward linkage creation with domestic firms is difficult. Hence, for better outcomes for the investments that come in through the PLI, India may want to emphasize domestic backward

linkage creation or a minimum domestic value addition in all mobile phones manufactured in India. For this the Indian government should announce incentives for local firms to establish linkages with mobile manufacturing MNCs.

- Third, given India's huge but relatively low value domestic market, local Indian firms can learn a lesson or two from the strategy followed by the Chinese in their domestic market. Chinese firms such as Xiaomi have shown that there is scope for firms from latecomer countries to increase their value addition by focussing on the downstream activities such as branding, marketing etc. A first step for Indian firms could be investing in R&D capability which will help them understand local needs and create a unique selling point.

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Notes

Editor's note:

A note of dissent from the anonymous referee and the author's response –
While the paper was approved for publication by the anonymous reviewer, they did stipulate that their comments and the author's response should be published along with the paper to reflect the referee's dissent on the conclusions drawn from the industrial policy and manufacturing experience of Asian countries. The notes below with numerical superscripts are standard endnotes and those with superscripts of alphabets are the referee's comments and the author's response.

[#] This paper has been a spin-off of a larger work 'Industrialization for Jobs and Growth: A case study of Cellular Mobile phone manufacturers in India', by the same author, supported by the Ford Foundation-IGIDR project 'Industrialization for Jobs and Growth'. Ref: Iyer, C.G. (2020). Industrialization for Jobs and Growth: A case study of Cellular Mobile phone manufacturers in India, paper written for the Ford Foundation-IGIDR project 'Industrialization for Jobs and Growth'.
A major part of this project has been published as a CDS Working paper 502. Ref: Iyer, C.G. (2021). Mobile Phone Manufacturing in India: A study of few characteristics. Working paper No. 502, Centre for Development Studies, Thiruvananthapuram, Kerala, India.
A brief version of the FF project & CDS working paper was published as "Mobile Phone Manufacturing in India: A Study of Few Characteristics" in the EPW on 19 February 2022.
I want to thank the anonymous referee whose two rounds of comments have considerably improved the paper. I also thank Mr. V. Sriram (CDS Chief Librarian) for his prompt response to all my paper requests. I am responsible for any errors that remain.

[1] Four firms – LG, Samsung, Hyundai, and Maxon – were responsible for the production of CDMA systems (equipment, facilities, and handsets). Mobile telecommunication service providers were instructed by the Ministry of Information and Communication to buy the systems from these four firms that had heavily invested in setting up production units (Park, 2013).

[2] The global firms chose the Global System for Mobile Communications (GSM) technology.

[3] Chang and Zach (2019) mention that, conditional on improving export performance, the Korean government also provided export subsidies. Given the small domestic market, this may have incentivised the CDMA manufacturers to focus on exports.

[a] The referee commented that "*that co-development with an international partner plus support for early deployment was the lesson here.*" We agree with the comment, however, from the South Korean experience we want to focus on the broader point of capability development. Of course, international collaborations is one strategy to achieve capability development.

[4] This is surprising given the fragmentation of production and relevance of GVCs.

[b] Since CDMA/GSM is just one part of the mobile phone, to get a complete picture of the South Korean experience, the referee commented that it may be worthwhile to investigate the South Korean experience in other segments of mobile phone production. The referee's observations on investigating other segments are well taken, however, in this paper we summarize Taiwan and the South Korean experience to emphasize the importance of capabilities, hence do not focus on all the segments.

[5] Imai & Shiu (2007) sum up this success as a marketing-focused strategy based on borrowed technology.

[6] 3G implies the third-generation wireless mobile technology.

[7] As shown by the South Korean example.

[8] Starting in the late '80s and early '90s.

[c] This inference of ours from the reading of Ernst (2014) has been challenged by the referee through the following comment "*This claim needs a lot more evidence. Vietnam etc were also signatories to the ITA-1. India got significant relaxations for increasing import tariffs. Nokia production began after ITA-1 implementation in India. So how is ITA-1 to blame? How did it discourage investors from scaling?*" & "*Seems like a correlation which is true only for India which is being proposed as a causation. Ref: https://takshashila.org.in/research/analysing-indias-position-information-technology-agreement*". We encourage the reader to read Ernst (2014) and the reference cited in the referee's comment for further clarifications.

[9] Data for other sub-segments are unavailable from 1997, hence have not been reported.

[d] The referee commented "*why did that not happen in China and Vietnam? Their experience is covered in Paper Tigers, Hidden Dragons (Fuller)*". Our response was "*As mentioned later, the Vietnamese experience is the same of no domestic backward linkages.*"

[10] A new scheme called the Remission of Duties or Taxes On Export Product (RoDTEP) has replaced MEIS starting 1 January, 2021. This new scheme is World Trade Organization (WTO) compliant. However, at the time of writing this paper, the rates under RoDTEP had to be finalized and notified. Source: https://www.livemint.com/news/india/government-caps-export-incentives-under-meis-at-rs-2-crore-11599033075428.html, accessed on 28 September 2020.

[11] In September 2019, Taiwan has raised a WTO complaint against the duties levied on few goods under the PMP. A panel to look into the complaint has been constituted in September 2020.

[12] As shown in table 5, given the structure of the global mobile phone industry, increasing exports in no way implies that mobile manufacturing in India is competitive.

[13] https://www.outlookbusiness.com/pixtory/graphically-speaking/lord-of-the-rings-4794, last accessed on 23 June 2020.

[14] An industry insider mentioned that components are being imported without duties using ITA-1 or FTA provisions.

[15] Annual Survey of Industries (ASI) is the principal source of Industrial Statistics in India; see http://mospi.nic.in/annual-survey-industries, for further information.

[16] For select mobile models - Apple iPhone7, Samsung Galaxy 7, and Huawei P9.

[1717] Ding and Pan (2011) note that the Shanzhai system - world's largest cell phone industrial cluster - comprised of thousands of small firms that relied on a Mediatek baseband chipset and sold primarily in the North Huaqiang market in China.

[18] https://www.livemint.com/Companies/UkSpqypNBO7Jb2LnZyCizL/A-bright-spot-for-Modis-Make-in-India-Smartphone-manufac.html, last accessed on 8 February 2019.

[19] C-DoT-designed digital switching equipment was produced by 50 manufacturers that C-DoT identified, trained, and licensed the technology to. A majority of components for the equipment was sourced from 372 local component manufacturers, who invested a total of Rs. 4.5 billion ($150 million) by 1995, employing some 20,000 personnel (Ray and Ray, 2010).

[20] See https://dot.gov.in/circular-and-notifications/3199, last accessed on 11 June 2024.

[e] India has a lot to learn from South Korea and Taiwan, however, in this paper we wish to focus only on the recent experiences of China and Vietnam. The referee's comment is reproduced here "*why not employ the South Korea or Taiwanese strategy? Might be useful to emphasize the difference here since those cases are covered in the first part of the paper. And in China too, how did Huawei climb the innovation ladder? That might be useful to add for the IP section.*"

[f] The referee commented that "*In this case, you are agreeing that China's strategy to globalise first and localise later worked. In South Korea's case, the paper is firmly saying the opposite.*" Our response was "*The aim of section 4.1 is to present evidence. Given different starting points as well as changing global environments, what works for one country may or may not work for another.*"

[g] For this sentence, the referee commented that "*There is a long-standing notion that wherever Apple has its FATP, it is in its interest to develop domestic sourcing in order to meet the gruelling demand of getting a new phone out every Christmas.*" Our response was "*We have just presented a summary of Xing (2019). Interested reader is encouraged to read the paper.*"

[21] Smile curve is a graph of value added (Y-axis) versus upstream, midstream, and downstream production activities (X-axis).

[22] Indian government has been making efforts in the past 3-4 years to come up with its own 6G standards. See https://dot.gov.in/circular-and-notifications/3199, last accessed on 11 June 2024.

[23] As we have seen in the Korean and Chinese example.

[24] The government has indicated that mobile PLI may be extended beyond 2026. See https://www.financialexpress.com/business/industry-mobile-pli-may-be-extended-beyond-2026-3497936/, last accessed 11 June 2024.