SEZs, Technology Spillovers and Industrial Diversification : Evidence from India

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I. Introduction

Special Economic Zones (SEZs) are a rapidly developing international phenomenon which affects an increasing share of trade flows at the international level and employ a growing number of workers. In the global economy, SEZs are viewed not as a source of generating foreign exchange but as a platform for promoting export led industrialisation. One of the major objectives of SEZs is to encourage transfers of new technologies and promote new skills to diversify the industrial structure. Yet, surprisingly little is known about the role of SEZs in technological development and industrial diversification. This study provides a systematic analysis of the contribution that SEZs have made to technological capabilities and industrial diversification at the sectoral level in India. It first explores the importance and nature of technology transfer and technology creation efforts in SEZs. The analysis is based on a fully structured questionnaire based survey of technology management in 75 firms across three SEZs: Santacruz (SESEZ) SEZ, Madras SEZ and Noida SEZ. It then examines success stories of technology transfer/creation in introducing new products and promoting new industries in the country. This part of the analysis is based on extensive interviews with zone entrepreneurs in ten operational zones. Of these, seven are the Central Government zones while three others are new upcoming zones.

Our analysis reveals that SEZs have had a catalytic effect on industrial diversification through the process of technology transfers and spillovers. They helped the country in exporting new products and in building up the country's image in certain products in international markets. Though they could not induce technology-based dynamism in the local or national economy due to relatively small scales of operations compared with the domestic tariff area, they did play an important role in seeding new industries and transforming some of the existing industries. The introduction of the new SEZ policy is expected to further enhance the role of SEZs in export-led

industrialisation. It is likely to give a big push to exports, employment and investment in the SEZs. The Ministry of Commerce claims that 124 zones that have already been notified by 6 June 2007, are expected to attract the total investment of about Rs 1,48,440 crore including FDI and create additional 15,46,569 jobs by December 2009. Investment made in these zones has already crossed Rs. 35000 crs and has generated employment for 32,578 persons. This is expected to result in significant inflows of technology and knowledge in SEZs and subsequently, in the rest of the economy through spillover effects.

The study starts by outlining a theoretical framework, in Section II. It identifies various channels through which SEZs contribute to technological development. Section III examines the empirical evidence on technology transfer and technology creation efforts in SEZs in India. Section IV discusses successful case studies of technology introduction and its impact on industrial diversification. Finally, Section V concludes the analysis.

II. SEZs and Technology : A Theoretical Framework

In a globalising economy continuous improvement in product, process, technology and organization have become the keys to sustained competitiveness. Firms are thus under tremendous pressure to innovate and change, restructure their operations and achieve efficiencies in production. However, developing countries' firms lack the technical, marketing and managerial know-how and they seldom have access to international distribution channels. It is believed that SEZs are of particular interest to developing countries because they attract technology transfers, promote local R&D, and generate technology spillover effects to upgrade technology standards in the economy. There are thus three channels through which SEZs are expected to contribute to technological development and industrial diversification:

1. technology transfer,
2. in-house R&D, and
3. technology spillovers.

Technology transfer is an important means by which developing countries gain access to technologies that are new to them. Technology transfers could be realized through three

mechanisms: new capital equipments, technology licensing, and foreign direct investment. SEZs offer a highly conducive investment climate to attract export oriented FDI by making up for infrastructural deficiencies and procedural complexities that characterize developing countries. Foreign direct investment is associated with the transfer of knowledge in two forms: one, the hard," possibly patentable, aspects of production technology, like the specifications of goods and the mechanistic details of their manufacture and two, the "soft" aspects of business processes, such as organization, marketing, and other types of managerial knowledge and skills (Stewart 1977). While the transfer of hard technology may be formal and contractual, the latter include all the channels by which managerial know-how and techniques can be passed on, such as on-the-job learning and demonstration effects (Ahiakpor 1990). Further, SEZs facilitate the insertion of domestic SMEs (small and medium enterprises) into global value chains by offering them an enabling investment climate (Gereffi et.al 2005). Global standards, low-cost competition, and advances in technology raise challenges for the SEZ units competing in global value chains. Participation in these chains on contractual basis allows producers to upgrade themselves technologically on continuous basis (Heron 2004). This stimulates learning and innovation, which are crucial aspects of human development. By having established a range of technological skills through learning, these firms transform into 'original brand name manufacturing'.

Technology transfers through arms' length licensing and capital goods imports promote domestic R&D activities also. Clustering of firms within SEZs promotes interactions between individual firms, workers, management, equipment suppliers, technological institutes and marketing firms. This interactive learning helps in making the production more and more efficient and developing small product innovations (Enright 2001, Lundvall 2002). Clustering also promotes the growth of shippers, logistics service providers, IT vendors, providers of customized business development services; infrastructure providers, regulatory agencies, research institutions, consultants and other logistics-related organisations in and around the cluster that leverage on the inter-dependencies between them to provide efficient and effective logistics solutions and create innovative new solutions, cut costs , and create external economies.

Learning and knowledge created in SEZs is eventually transmitted to domestic firms supplying to the SEZ firms through backward and forward linkages. There are two main channels of

backward linkages: utilization of domestic raw material inputs and subcontracting arrangements with domestic firms. These arrangements would integrate the zone into the regional and national economy by allowing domestic firms to step in as suppliers to the SEZ firms and would in turn, promote regional development by creating demand for local products and services, and transferring technology to the local economy. Eventually, the domestic supplier firms would also mature to compete in the international market. Knowledge spillover and demonstration effect thus acts as a catalyst for learning and human capital development. Forward linkages are said to arise if exports are allowed to the local market. This induces introduction of new products and new activity in the domestic mainland and thereby promotes industrial diversification. It is assumed in the literature that forward linkages are not relevant in the context of SEZs since SEZ firms in general are not allowed to sell in the domestic market (Warr 1989). What is neglected in the literature is that trade bodies, manufacturers' associations and export marketing bodies which provide a useful platform to interact and to foster closer rapport among members act as valuable forums for information sharing and spillovers. Furthermore, FDI triggers off technology transfer and spillovers first within the zone, and then between the zone and the rest of the country through various channels such as copying, reverse engineering and movement of workers and managers between foreign and domestic companies. Direct transaction of technology or licensing of codified knowledge in the form of blueprints and designs and capital goods imports also generate positive spillovers by creating learning and teaching effects. Finally, factors such as on-the- job training of the labour, exposure to notions of punctuality, quality control and meeting deadlines have an effect on how growth of the SEZs translates into skill upgradation of labour and higher earnings. All these effects upgrade and widen the domestic knowledge base and upgrade the sectoral and regional innovation systems. Thus, SEZs are not enclaves/foreign territories that are functioning in isolation, as many would like to believe.

Technology spillovers facilitate introduction of new products and processes in the rest of the economy as well, which in turn promotes industrial diversification. Further, global supply chains offer local entrepreneurs low risk method of entering the export markets which ultimately enable them to move from simple assembly tasks towards the production of items with higher local value added (Heron 2004) through spillover effects. For instance, many local firms become responsible for original equipment manufacturing (OEM) wherein they source raw materials

locally and manufacture products to the specification of foreign buyers. But having established a range of technological skills through learning, these firms transfer into "original brand name manufacturing" (OBM). Madani (1999, p.30) argues that such transfers between zones and MNCs, together with the "catalyst" factor, would foster shift to the production of non- traditional goods and efficiency gains in production processes of the traditional ones in the zones. Finally, industrial diversification occurs when zone entrepreneurs diversify their business into the domestic markets and introduce new products and technology there, and when there are information spillovers from SEZs to the domestic mainland through interactions between the zone and domestic entrepreneurs.

The preceding discussion notwithstanding, empirical evidence suggests that technology related effects of SEZs have not been across the board and wide-spread (Madani 1999). Three major explanations are offered within the above framework. First, it is argued that zones are dominated by labour intensive low tech firms engaged in assembly type operations, which do not compete on the basis of technology. The low skill assembly type operations in the SEZs leave little scope for technology transfers (Madani 1999, Heron 2004 , Armas and Sadni-Jallab 2002 among many others). In such supplier dominated industries technology does not change rapidly and mature technology is used. Technology transfers and possibilities of spillovers may therefore be severely limited and technology transfers may not be occurring on a continuous basis. Second, the extent of FDI attracted may be insignificantly small to create any significant effect. Third, backward linkages may be weak or even non existent. Low levels of backward linkages may partly be attributed to the fact that zone firms import a large proportion of their raw and intermediate inputs from the rest of the world leading to low value addition within the zones. Jenkins et al (1998) for Central American zones, Mondal (2002) for Bangladesh zones, Amirahmadi and Wu (1995) for Asian zones among others report low value addition by zone units. Kusago and Tzannotos (1998) find that the countries with higher ratio of local content experienced a leap from low level of local sourcing to high level over a short period. This happened over four years (3.3% in 1971 to 24.4% in 1975) in the Republic of Korea and over 5 years (2.7% in 1982 to 17.7% in 1987) in Malaysia. In several countries local sourcing is limited, such as in the case of *Maquiladoras* in Mexico. Slow delivery, high prices, poor quality, weak or non-existent physical and business infrastructure, issues of supply reliability and non-competitive pricing of domestic

raw or intermediate good are some of the factors for weak backward linkages with the rest of the economy. The corporate policies of international firms and the regulations and laws of the firms' home countries may also discourage them from creating a long term relationship with a domestic supplier . For instance the U.S. law on the Carribean countries' SEZ firms forced them to use the US inputs, which discouraged the formation of backward linkages of zone firms with the local economy.

Empirical evidence on technology-related effects of SEZs is scarce. However, literature suggests that SEZ effects are zone and country specific (Kusago and Tzannotos 1998). These effects depend on the zones' ability to attract FDI and continuous technology transfers and forge backward linkages with the rest of the economy. SEZs may be distinguished on the basis of location, the types of firms located, skill component of the economic activity of firms and the types of employment generated. If SEZs are dominated by assembly type low skill labour intensive production, they primarily provide employment for unskilled workers and for those at the lower end of income distribution. Their effects on technological development may be negligible. If however, SEZs are dominated by production activities, which require sophisticated production processes and technologies they may become important contributors to technology generation, transfers and technological spillovers. Much therefore depends on the composition of activities in the zones.

Further, SEZs which are better integrated into the domestic economy are likely to contribute to technology upgradation more significantly than the SEZs that are isolated enclaves of production. Linkages occur in those developing countries where a large industrial base already exists. In countries such as Malaysia (Wijewardane 1993), Taiwan (Wang 1990), Indonesia and Korea (Cling and Letlilly, 2001) there have definitely been successful linkages between zone firms and domestic suppliers which have had a catalyst effect on technology transfer and spillovers. Government's role may also play an important role in enhancing backward linkages of the zones with the rest of the economy.

Much also depends on the national capacity of absorbing and learning through the spillovers. Kokko and Blomstrom (1994) argue that absorptive capabilities of domestic economy are a

crucial factor in determining spill over effects. The smaller the technology gap between host and home country the greater will be the spill overs.

In what follows we analyse the role of SEZs in technology transfers, technology creation and industrial diversification in India.

III. Empirical Evidence in India

In India's SEZs, firms from different sectors coexist. Table 1 presents zone-wise sectoral composition of exports. It shows that export patterns are very different across zones. A high share of gems and jewellery in SEZ exports is due primarily to the predominance of this sector in SEEPZ SEZ, Noida NSEZ (NSEZ) and Vizag SEZ (VSEZ). Cochin (CSEZ) specializes in electronics hardware, while Falta (FSEZ) is dominated by textile units. Kandla SEZ (KASEZ) has a high share of Chemical firms and Madras SEZ (MSEZ) has a high share of engineering sector. Apparently, as compared to SEZs of many other nations, the Indian SEZ regime is well diversified in terms of the economic sectors represented in the zones.

Table 1: Zone-wise sectoral composition of exports : 2004-05 (%)

	CSEZ	FSEZ	KASEZ	MSEZ	NSEZ	SESEZ	VSEZ
Electronic HW	49	0	0	10	9	13	0
Electronic SW	2	0	0	19	13	13	1.5
Textile	8	60	13	22	6	0	0
Rubber/plastic	4	6	2	1	2	0	0
Engineering	9	7	11	28	12	0	0.1
Food	10	9	8	0	0	0	0
Gems & Jewellery	4	3	0	6	48	74	93.7
Chemical & drugs	0	1	63	7	0	0	0
Leather	0	11	0	6	0	0	0
Mis	14	3	3	3	13	0	4.5
Total	100	100	100	100*	100*	100	100

Source: Calculations based on the data collected from Development Commissioners' offices
*Discrepancy is due to rounding off the figures

The role of technology in the economic activities of the zones is therefore expected to be important. We asked the entrepreneurs how important are technology and other cost related factors in determining their competitiveness. Their response was measured on a scale of 1 to 3 where 1 referred to low ranking , 2 medium ranking while 3 high ranking. For each sector mean of the entrepreneurs' response was calculated and was deflated by 2 for examining the deviation from the medium response. The statistics (Table 2) reveals that cost related factors : cheap labour, raw material and finance charges, are generally rated below average while technology related factors: technology used, quality of product and scale of production, are rated above average. Sector –wise analysis suggests that in all the sectors, technology related factors are rated more highly than the cost related factors. Quality is considered to be the most important determinant of competitiveness followed by scale factor and technology used.

Table 2: Contribution of selected factors to firms' competitiveness in the zones

sector	Cheap labour	Raw material	Finance charges	Technology used	Quality of product	Scale of production
Chemical	80	90	80	90	130	130
Mis	75	95	95	95	125	100
Engineering products	90	100	90	100	100	90
Textiles	100	100	90	110	130	120
Pharmaceutical	100	110	100	120	120	110
Gems and Jewellery	95	80	85	125	140	105
Electronics	80	90	85	125	140	125
Rubber and Plastic	100	100	100	135	150	115
Average	90	95	90	110	130	110

Source : Primary survey

To examine the technology intensity of the activities in the zones we asked the managers how frequently technology changes in their area of production. Summary information is compiled in the form of an index with "2" as the base which represents average on our scale in Table 3. The results show that most economic activities in the zone are medium tech activities.

Table 3 : Technology intensity of economic activities in the zones by sector

Sector	Technology index with base=2
Chemical	100
Miscellaneous	90
Engineering products	110
Textiles	100
Pharmaceutical	120
Gems and jewellery	95
Electronics	105
Rubber and plastics	115
Over all	105

Source: Primary Survey

Table 4 shows the level of sophistication of technology used in economic activities in the zones. It reveals that most producers are using the technology, which is not the latest or the most

Table 4: The level of sophistication of technology used in production

Level of technology used→	latest	Medium	old	Not available
No. of firms	5	46	23	1
Share in total	30.7	61.33	6.7	

Source : Primary Survey

sophisticated. They are using technology of medium vintage.

Technology component is expected to further increase in India's SEZs with a number of new SEZs upcoming in high tech sectors such as IT, electronics, pharmaceutical and biotech. In the following analysis, we shall examine the approaches of SEZ firms to technology transfer and technology creation in existing zones.

Technology transfers

As discussed earlier, technology transfer takes place in three different ways: foreign direct investment, arms' length licensing (including technical consultancy) and acquisition of capital goods. Most technology is transferred between developed and developing countries through these modes of commercial technology transfers.

Direct foreign investment : We gathered information on the share of FDI in eight SEZs that had been operational by 2000. The information is summarized in Table 5. It shows that SEZs in India continue to be dominated by domestic investment. The share of FDI in total investment increased slowly from 12% in 1989 to slightly over 18% in

Table 5 : Share of FDI in total SEZ investment in 2003: (%)

	India
Noida	19.9
Chennai	35.0
Mumbai	19.2
Cochin	20.1
Kandla	8.1
Falta	6.3
Vishakhapatnam	40.0
Surat	0.0

Sources : Ministry of Commerce, Government of India

2000. During 2000-2003, FDI inflows increased faster. By 2003, its share in total investment had increased to 24%. However it remained around one fourth of total investment in the zones. This limits the scope of even the transfer of soft technologies and demonstration effects arising from this.

For examining the transfer of the hard technology by MNEs in three selected zones, we asked their management to rank the vintage of their technology on a three point scale. Our sample had 16 foreign firms. Of them, only 6 reported that they are using the latest technologies. Mean response of foreign firms to technology transfer is 2.25, which turned out to be the same for the purely local firms as well. This is interpreted as an evidence of the foreign investors' unwillingness to transmit up to date technology. In China also a number of empirical works highlight the fact that in many cases foreign affiliates of western MNCs are locked in low value-added productions (Lemoine and Ünual-Kesenci, 2004). In addition, many examples of limited transfer of innovation skills in Dalian city were found. An investigation on a sample of FDI enterprises in one of the fourteen Economic and Development Zones set up by the Chinese government in 1984 in Dalian put to the fore that about one sixth of them did not bring from abroad any new products or equipment (Lan and Young 1996).

One may therefore argue that MNEs may help in diffusing technologies in developing countries by relocating mature products to take advantage of low wages in developing countries but their contribution in upgrading technological standards in these countries may not be significant (Praussello 2005). High level knowledge transfers tend to be strictly controlled by the foreign partner, or restricted or even bluntly prohibited. This is not peculiar to the zone sector alone but is an observed phenomenon in the rest of the economy also. In a recent study (Bhaumik et al (2003) it is observed that most MNEs are not carrying out R&D operations in India and that the extent of training provided to local employees is not significant.

Technology Imports : Technology imports are formalised through payments and contracts. Many scholars argue that technology imports have been the most important factor in explaining the rapid economic growth of Japan, Taiwan, South Korea, and other newly industrialized countries. While examining the importance of technology imports in the zones in India, we asked

firms whether they import technology. Of the 70 firms that responded, 36 informed that they used licensed technology (Table 6). There have however been sectoral variations. While 75 percent of pharmaceutical and textile sector units have reported licensing arrangements, only 25 percent units in the chemical , rubber and plastics and other sectors have been using imported technologies. The average share of units importing technologies in electronics, engineering and gems and jewellery is 50 percent.

Table 6: Incidence of technology licensing in zones by sector

sector	Reporting firms	Total number of firms	% of firms importing technology
Pharmaceutical	4	5	80
Textiles/garment	4	5	80
Chemicals	1	4	25
Electronics	7	15	46. 7
Engineering products	5	12	41. 7
Gems and jewellery	11	20	55
Misc	3	10	30
Plastic	1	4	25
Total	36	75	48

Source: Primary Survey

Our investigations revealed that a majority of firms importing technologies update the technology on continuous basis by importing it. For cross examining them, we asked if they have made any technology related payment during the last three years, 34 responded positively. Thus , technology transfers through licensing arrangement is more common in the zones.

Capital goods acquisition : The most popular mode of technology imports in the zones is the use of imported machinery with 62 of the 75 firms making use of imported machinery. Thus technology transfer in embodied form is the most common form of technology transfer. Most

firms are updating their technology through imports of machinery. We asked them the age of their latest machinery. Of the 75 sampled firms, 67 responded. The summary information is provided in Table 7. For most firms it is one year or less. In a study on the determinants of export competitiveness in Indian industry, Aggarwal (2002) found a strong relationship between imports of technology and export performance of firms in low and medium tech industries in India outside the zone sector. It was argued that in such industries technologies are widely diffused and are mainly embodied in capital goods.

Table 7: Distribution of the vintage of latest machinery

Vintage of latest machinery	Number of firms
Less than a year	21
One year	23
1-2	9
2-3	7
More than 3 years	6

Source : Primary Survey

In sum, the overall patterns of technology transfers and their relationships with exports in the zones is not very different from the exporting sector in the rest of the economy. Technology imports occur mainly through capital goods imports. Technology licensing is another form of technology transfers. Thus, even if zones are not attracting foreign direct investment, technology transfer component is substantial. Most firms are updating their technology either through licensing or imports of capital goods.

Technology creation

Technology transfers do not help building technological capabilities. This requires assimilation and adoption of imported technology, which highlights the need for having well developed in-house R&D capabilities. It is therefore important to analyse the R&D activities within the units. We asked several questions relating to R&D activities performed by the units. Our findings suggest that spending on R&D is rather low. Only 21 firms reported to have incurred R&D

expenditures. Investing in R&D is below the threshold of 1% of their turnover. Most SEZ units do not have separate R&D departments. Only 15 units have reported that they have employed R&D personnels. R&D activities are centred on minor innovations, modification or improvement of existing technologies and much of this is towards quality control.

These findings are quite consistent with the R&D behaviour of firms outside the zones. Kumar and Aggarwal (2005) anlysed R&D expenditures of over 600 R&D performing firms. They revealed that the average R&D intensity (R&D expenditure to sales turnover ratio) of all enterprises for the entire period was less than 1 per cent. In another survey (conducted for Kumar and Aggarwal 2000), they asked firms (outside the zone) to rank the various types of R&D activities according to their importance in their unit on a 1 to 5 scale. It was found that a majority of firms were focusing on quality control and adaptation of imported technologies. They had no orientation for fundamental research. Aggarwal (2001) found low spending on R&D, low reliance on local knowledge institutions and high reliance on foreign embodied science and technology (machinery) as the distinctive characteristics of the firms in India. She concluded that firms have mostly grown without deepening their technological capabilities and where technological learning has existed, has been very slow and passive. Findings of the present study do not appear to be different. Generally it is believed that export orientation promotes R&D activities and learnings. However responses to our questionnaire suggest that zones are dominated by medium tech activities and there is limited technology transfers and in-house R&D activities. Their role in promoting technological development therefore remains rather limited.

However, during our unstructured interviews with entrepreneurs and visits to firms across all SEZs we observed that R&D activities are indeed articulated with the enterprise strategy. Most firms have developed shop floor (informal) R&D facilities for cost cutting and quality improvements. The focus of R&D is directed to producing new materials, products or devices, installing new processes, systems and services, or improving substantially those already produced or installed. In consumer oriented sectors such as textile products, metal products and gems and jewellery, firms primarily focus on design and product development. Generally, it is believed that contract manufacturing does not allow firms to upgrade their technological prowess. However, there have been instances where contract manufacturer firms have developed

R&D capabilities. Sun Fibres Optics (NeST group), a contract manufacturer company located in the Cochin SEZ is a good example for illustrating this observation. The company has a well developed R&D lab and R&D facilities and has acquired skills to provide consultancies to the firm for which they have been manufacturing. In 2000, they started supplying the GE Medicals full ultra sound scanners, of which 60% parts are produced internally and 40% parts are outsourced from Wipro another local company. These examples are not common but they exist. Many firms involved in contract manufacturing admitted that the scope for R&D was limited in this form of manufacturing. Firms that have marketing tie ups with retail chains or foreign firms, however, have a greater incentive to conduct R&D to cut costs and improve quality in order to compete in the markets. Almost all such firms have developed some sort of R&D capabilities depending on the requirement to sustain themselves in the competition.

Table 11 lists some of the technologies introduced by the units in the zones.

Table 12: Selected examples of technology transferred/developed in the zones

Gems and jewellery	➢ Wax setting technology ➢ Electroforming in producing large and hollow jewellery technology	Introdcued in India (jewellery)
Metal products	➢ Technology of mixing mirroring with steel, mixing gold with steel, ➢ gold brushing	Utencils, Developed in India Transferred
Metal products	➢ Powder technology for steel furniture ➢ Mobile capacitators	Transferred Developed
Engineering sector	➢ Cheap technology for industrial evaporators	developed

	suitable for developing countries	
Chemicals	➢ Polarised lens	Transferred
Rubber	➢ Automated dipping technology	Rubber gloves, transferred
Food processing sector	➢ Ripe fruit chips	Snacks, transferred
Electronics	➢ Several new products which had no markets or production technologies in India. For instance, thermatically sealed relays, cable monitoring systems, CAS	transferred
Textiles	➢ Linen manufacturing,	Fabrics, transferred

Source : Our Interviews with zone entrepreneurs

Clearly, firms supplying to international markets are exposed to superior technologies, processes and managerial techniques. In order to survive in these markets, they have to import these technologies and management processes and absorb and assimilate them. Most scholars emphasize that it is FDI that that acts as catalyst to growth through spillover and demonstration effects. However, we found that even domestic export oriented investment, is normally accompanied by technological transfer, knowledge and skill transfers and local technology efforts.

Zones might be providing avenues for foreign direct investors, enterprising entrepreneurs and technology transfers but the SEZs' effectiveness as instrument for achieving long-term industrial development would largely depend on the degree of backward and forward linkages created with domestic economy. Technologies and skills are expected to spill over not only to other zone

firms but also to entrepreneurs in the domestic mainland through the linkage effects. It is therefore important to examine whether SEZs have succeeded in forging strong linkages with the rest of the economy. Four indicators of linkages are analysed here.

- Value addition (Net exports)
- Domestic procurement
- subcontracting.
- Domestic sales

The degree of value addition for this analysis is defined as the net exports as a percentage of total exports. Value addition figures for Indian SEZs are provided in Table 8. It shows that SEZs had never been dominated by low value added assembly type operations in India. Import content was not allowed to exceed the specified limits through highly regulatory government policies.

Table 8: Trends in value addition (Net exports to total export ratio) : 1974-2002

Zone	1975-1985	1985-1991	1991-00	2000-06
Cochin		5.1	36.5	35.9
Falta		-7.7	32.7	79.0
Kandla	43.9	41.9	65.0	60.7
Madras		-67.1	26.4	53.0
Noida		42.7	41.2	42.6
SEEPZ	23.9	26.5	45.1	51.3
Vizag			-202.1*	-41.9
Average	36.0	31.6	43.8	48.1

Source : Calculations based on the Ministry of Commerce Data
*since 1994-95

The average net value addition in the 1970s was as high as 36%, which increased gradually to 48 percent by 2000-06. Low value addition during the 1980s was due to the gestation period of the new zones. Value addition is a good economic indicator not only of foreign exchange earning potential but also of linkages. A large component of value addition implies more economic activity in the home country of SEZ. However, a large component of value addition could be due

to wages and profits. Domestic procurement therefore is considered be a more appropriate indicator of backward linkages.

Domestic procurement indicates the utilisation of domestic resources in total input use. Information on domestic procurement is not easily available. We collected the information on procurement from zone authorities for the period from 2000-01 to 2005-06. On an average, the local content in total imports into the zone sector had been mere 9%. Fitting (1982) reports that by 1982, 32.4% of the goods shipped into the SEZs were accounted for by local inputs in Korea. In comparison, this ratio for India compares very unfavourably. The practice of domestic subcontracting is also uncommon. Units complained of poor work culture and poor quality outside the zones. Many entrepreneurs echoed that outside units do not adhere to strict time schedule, which offsets the planning of the zone units. Many units therefore prefer to subcontract within the zone. Domestic sales are frictional, contrary to the popular belief. Does this mean that SEZs in India are isolated enclaves as suggested in the literature? The answer is "no". There are two important channels that promote technology spillovers and forward linkages between the zones and the domestic mainland and which find little mention in the literature. These are namely,

- Geographical diversification by entrepreneurs into domestic markets; and
- information spillovers through manufacturers' associations and export marketing infrastructure.

Diversification by entrepreneurs into domestic markets : It is observed that many firms set up production units in domestic mainland to cater to domestic markets after succeeding in export markets. This is because, exporters are exposed to new methods of doing businesses, new managerial techniques and new technologies and certain marketing capabilities associated with brand images. Intangible quality of these assets prevents the firm from fully exploiting its value in a single market. Diversification strategies are a method of exploiting intangible assets—especially in areas where these assets are more prevalent. The strategy of setting up domestic units also serves as an important means of risk-spreading, safeguarding corporate revenues from demand shocks in key product markets. Diversification into domestic markets by zone units

introduces new products and new technologies in the domestic mainland and is a crucial link between the zones and the domestic economy

Information Spillovers through Export Infrastructure : Trade bodies, Manufacturers Associations and export marketing bodies provide a platform to interact and to foster closer rapport among members. Almost every industry has its own association of members and export development body. These associations spearhead the industry's growth and organize various activities to disseminate information, arrange dialogues between members of various sub-process groups, upgrade the technological level of the industry and promote marketing activities by organising seminars, talks, forums and conferences; organising short-term courses on technological upgradation; organising and participating in trade missions and trade exhibitions, co-ordinating the display of members' products via the Internet; publishing in-house magazine informing members on the latest technologies and industry developments.

Thus, even though formal backward and forward linkages are not prominent, there are significant information spillovers and demonstration effects, which are effective channels of technology spillovers and industrial diversification. It is therefore expected that SEZs in India would have strong linkage effects with the domestic mainland and facilitate industrial diversification.

Our interviews with zone entrepreneurs revealed that SEZs have played an important role in industrial diversification in India by introducing new products and technologies. Some of the success stories are discussed in the next section.

IV. Technology spillovers and Industrialisation: Success Stories

Gems and Jewellery Industry

India has always been known as a diamond processing hub. Up until 1725, India was the only known producer of diamonds. However, the diamond industry in India slowly declined in the 18th century with the spread of the British colonial rule in India and the discovery of diamonds in Brazil and South Africa. After India gained its independence in 1947, the diamond processing

industry started to develop again. The industry grew tremendously over the years and soon India emerged as one of the biggest cutting and polishing center in the world. According to Wikipedia, the free encyclopedia, India processes 11 out of 12 diamonds in jewellery worldwide. India's share in the global production of cut and polished diamonds is 95 per cent in terms of pieces, as per the Gem and Jewellery Export Promotion Council of India. However, the jewellery industry remained mostly family oriented and focused on the domestic market. The industry was a labour intensive cottage industry using the labour casting technology. In 1987-88, SESEZ was open to gems and jewellery units and it is here that the "wax setting/casting techniques" was introduced which laid the foundation of the modern gems and jewellery industry. The modern jewellery industry thus first took root in the export processing zone of Mumbai (SESEZ) in the late 1980s and it became the most glaring example of successful technology transfer, which dramatically transformed the jewellery industry in India.

The SESEZ Special Economic Zone is now the world's largest single concentration of jewellery manufacturing units with over 100 factories employing an estimated 15,000 people. The industry has registered a steady growth over the last decade, making it the fastest growing manufacturer in the world. Gems and jewellery today is the single largest industry in India accounting for 23% of total exports.

The industry has underwent a dramatic transformation. The old crowded workshops have made way for smart work floors with excellent working conditions for the staff. Professionals are employed at all levels of the industry, from senior management to technically skilled personal at all levels of production, as well as a rapidly growing number of trained designers who are products of specialized jewellery and fashion training schools. Vacuum pressure casting machines, magnetic pin finishers, laser marking systems, automatic state of art refining plants, automatic modular cleaning systems, disc and drag finishers, diffusion welding machines are being extensively used. There is a huge demand for the latest type of non-allergic rhodium alloys, new bases for smooth surface finish, etc. SESEZ is a leader in the introduction of the latest technologies in this industry. Processes are highly mechanized and factories are equipped with world class facilities.

The jewellery industry in Indian now has a larger number of CAD-CAM machines than any other centre in the world. It is estimated that that more than half of all jewellery CAM in the world can be found here.There is a huge emphasis on product development using a mix of trend forecasting based on market intelligence to new designs, high levels of technology and skill in manufacturing and finishing, and stringent systems of quality control.

As a result of all these factors, some of the world's largest jewellery retailers like Zale Corporation, J.C.Penny, Fred Myers and Wal Mart now directly source jewellery from companies in India, while some of the bigger international names from outside India have also set up units within the zone.

SESEZ has been making a huge contribution to the development of the jewellery industry both in terms of quality of the product and the expansion in terms of size. The success of the SESEZ units is being replicated by units across the country whether within or outside of Special Economic Zones. Noida SEZ has emerged as another major hub of jewellery exports. The Jaipur SEZ has already seen major growth over the last few years. Aside from gold jewellery, they have also begun manufacturing platinum jewellery and combination jewellery.

Table 9 highlights the role of SEZs in total jewellery (not gems) exports. Their share in total exports of jewellery which was 3.3 percent in 1988-89 increased to 56.5% by 1998-9 and thereafter it declined to 37% in 2004-05. This decline was not due to decline in the SEZ production but due to relatively faster increase in jewellery exports from the rest of the economy.

Table 9: Share of SEZs in jewellery exports in India (%)

Year	Share of SESEZ in Jewellery Exports	Share of SEZs in Jewellery exports
1988-89	3.3	3.3
1992-93	31.6	38.0
1996-97	38.3	38.7
1999-00	46.6	NA
2000-01	42.4	46.0
2001-02	41.3	46.5
2002-03	44.3	56.5
2003-04	33.4	38.6

2004-05	26.3	36.9

Source: Gems and Jewellery Export promotion Council and DCs' offices

Jewellery exporters are now aggressively looking to domestic markets. Most units are diversifying into local markets. For instance, Getanjali group which has promoted D'damas, Asmi, Nakshatra, Sangini, and Gili brand names intends 30 stores across the country by next March. The group is setting up a gems and jewellery SEZ in Hyderabad. Tara jewels which has promoted Rose Brand has 3 units in the domestic mainland. They are targeting upward markets. In addition Flawless Diamond, Classic jewels and many others have begun their retail thrust in major metro cities in India. This has transformed the unorganized domestic jewellery market in India into an organized and brand constious market.

The Electronics Industry

The electronics industry has extremely high rates of innovation. Moore's law (1965) reflects the rapid improvement in semiconductor performance, driving microprocessors, DRAM and various other chips. Since Electronic products incorporate ongoing innovation in components, they also have a high rate of depreciation. Depreciation costs are reduced by increasing inventory turnover within the plant and distribution channel, and also by reducing the time that products spend in transit from one location to another. Logistics and depreciation costs are most affected by infrastructure as they determine the time and cost involved in delivering a product to the customer. Short product cycles, technology obsolescence and intense competition add to the fast-pace nature and competitive pressures of the industry. SEZs by offering low cost production location,. highly efficient logistics, high tax incentives, duty free imports are thus highly relevant in this industry. They played a crucial role in the development of the industry in Taiwan and Malaysia (Wong and Chu 1984) . In view of the success of SEZs in East Asia in promoting the exports of electronics, it was thought to explore this possibility of promoting exports. The Sanatcruz SEZ was established with the specific objective of promoting electronics exports. Eventually, it played a crucial role in promoting this industry in India.

Table 10 reveals that, in the initial phases, the electronic hardware exports were primarily originating from the export processing zones. Export intensity of DTA firms was extremely low. During the early 1980s, SEZ exports were 2.5 times that of the domestic sector exports. In the late 1980s also SEZ exports remained higher than that of the domestic economy. In the post 1991 period, when several policy reforms were introduced by the government, the domestic circle responded favourably and the domestic sector exports overtook SEZ exports. Apparently, zones had been instrumental in creating the base for the growth of the industry through technology transfers, spillovers and demonstration effects.

Table 10 : The share of SEZs exports in electronics exports from India (%)

	Ratio of SEZ to DTA exports	Share of SEZs in total exports	Growth rate of exports from SEZ sector	Growth rate of exports from domestic land
1980-85	2.50	65.00	26.08	1.12
1985-90	1.06	54.00	44.78	82.07
1990-95	0.88	46.00	26.34	31.14
1995-00	0.50	35.00	28.96	34.34
2000-02	0.38	26.00	12.25	9.87

Source: Export Promotion Council for Electronics

The case study of Sonodyne yields some insight into how the exporting activity impacts on R&D capabilities and industrial upgradation of the domestic markets.

Sonodyne: Impact of exporting on domestic markets

In the late '60s, when the mono radio was being used in India, Ashoke Mukherjee, an engineer student from Roorkee University initiated the manufacturing of amplifiers and speakers. The concept of stereo sound was a very foreign one. But Ashoke Mukherjee brought it home.

He began with manufacturing battery eliminators in the late '60s. In 1970s he released stereo amplifiers. These were met with resounding success all over India. He laid the pathway for the development of Indian first hi fi R&D laboratory in India. Loudspeakers, and turntables hit the market in the mid '70s. Much of this success could be due to competition proof Indian markets.

In 1982, a 100% export oriented division, Sonodyne International Ltd. was established in SESEZ, Mumbai to manufacture professional audio, and power electronics equipment as an OEM for the European and American houses. In the meantime, the home market continued to

be presented with audio solutions catering primarily to the value conscious middle class.

In the early '90s, competition heated up with the entry of global giants. Sonodyne Electronics, in an attempt to counter the multinationals' extensive marketing with state of the art products, took a step back from domestic sales. It focused on the development of technological capabilities through technology transfers. For this it concentrated only on the exporting activities which exposed it to new technologies due to their exporting the high end products

The state of the art lab at SESEZ focused on turnkey design and development projects for OEM customers. The factory got ISO 9001 certified. After the hybernation of almost 10 years, it has re-launched itself in the domestic markets. Sonodyne Electronics manufactures over 40 different amplifier, speaker, and signal processing solutions in home audio, installed sound, public address, and cinema sound. Extensive technological interaction with leading manufacturers around the globe while exporting has facilitated the development of these products targeted at the Indian and world market. These products are indeed a departure from our products from the 70s and 80s. This is the first time that an Indian company has developed such stand-alone equipment of global standards for high end home and professional use.

Source: Website of the company supplemented with information collected during interviews with various units in SESEZ.

The Software Industry

Bangalore is known as the Silicon Valley of India. However, it was not Bangalore, but SESEZ Mumbai (Bombay), where the Indian software saga really began. It was the establishment of SESEZ that gave a head start to the software export industry. During the 1960s, imports of computers were highly regulated. This had inhibited the growth in software exports. In 1972, the government of India introduced a "Software export scheme". Hardware imports were permitted for the purpose of software development on the condition that the exporters recovered an export commitment equal to the price of computers imported. Tata Consultancy Services (TCS), Bombay, was the first company to export software under these guidelines. TCS, which was set up in 1968, got its first export assignment in 1973-74 after a few local orders. However the real breakthrough came when in 1977 the Tatas went into partnership with Burroughs (TBL), an American hardware company, to establish a unit in SESEZ to export software and peripherals. The Company got involved in manufacturing, marketing and exporting computer systems & peripherals; marketing, installation, maintenance and support of the equipment of UNISYS Corporation, U.S.A. in India and rendering of computer consultancy and development services

for the Indian & overseas market. Later, Tata Consultancy Services (TCS) also set up a large software house in SESEZ. Together TCS and TBL, became the largest Indian software exporters (Heeks, 1996, p. 69). TCS' Delivery Center for SESEZ is one of the largest Overseas Development Centers in India, with over 3000 professionals.

Thus the Indian software industry had become active by the late 1970s, but it was only in the mid-1980s that it became visible in the global software services market. In 1985, Citibank established a 100 per cent foreign-owned, export-oriented, offshore software company, (Citicorp Overseas Software Ltd, COSL) in the Santa Cruz Electronics Export Processing Zone (SESEZ) in Bombay. The company initially undertook software development work for the parent company and later diversified. This company drew attention to the possibilities available for offshore software development in India. This increased awareness of the capability of Indian programmers and engineers coincided with the severe shortage in the supply of programmers and software developers in the American software industry. Soon after, Texas Instruments and Hewlett-Packard established subsidiaries in Bangalore, in 1986 and 1989 respectively and the rest is history.

Rubber glove industry

The rubber glove is another story of successful technology transfer. In the late 1980s, the US made it mandatory for the doctors to use the gloves when they came in touch with the patient. This led to a tremendous increase in the demand for the product and eventually to offshoring of production. In Cochin SEZ, 8 factories were set up in this sector due to local availability of raw material. It was a cottage industry in India until then. There were moulds, which were dipped manually in rubber solution. The scale of production was very small at 500-1000 pieces per day. Asma was the first unit that introduced the "automated line dipping technology" in Cochin SEZ. Initially, Malaysian companies helped in setting up the plants. Space was provided to these companies and they implemented the production processes. The scale increased to 150000 pairs a day. Now, R&D processes are being developed to cut the cost. There are tie ups with the Cochin university, which is helping in developing the quality such as polymer coating of the gloves, fillers for latex. Value addition has increased. Zones offer inherent advantages to the rubber industry to grow. In rubber industry, facilities like water effluent treatment matters and

larger the capacities, smaller is the cost. Furthermore, rubber gloves manufacturers operate on very thin profit margins due to low prices therefore incentives also matter. In India rubber can be imported only through two ports –Kolkata and Vishakhapatman. But SEZ units can import it from anywhere. However, the industry could not build dynamism and is struggling for survival in the country with only half a percent share in global trade. Removal of barriers on its exports has led to its shortage in the market due to spur in exports and shot up its prices.

Electronics manufacturing service industry

Several new zones are being set up under the new SEZ policy. Currently, 19 SEZs are operational and 146 new SEZ are already notified. Analysis of the upcoming SEZs suggests that electronic manufacturing service and aerospace industries are hugely benefited by the scheme. Several electronic giants including Nokia, Motorola, Cisco, Foxconn, Samsung and Dell are investing in the SEZs on a long barren stretch of land along the Chennai-Bangalore highway. They have also roped in their global component-manufacturing partners to create vertically integrated clusters. Large investments have been incurred on plant and machinery. EMC, Dell, Nokia, Samsung, Flextronics, ST Microelectronics, Motorola and Ericsson will together bring in more than $1.8 billion in investments to Chennai and Sriperumbudur. Nokia had promised to invest $150 million over three years and employ 3800 people. According to the company sources it has already invested close to that figure. It has also managed to reach a head count of 2,500 within seven months of its operation. Indirect employment of about 10,000 is already created. It rolled out its 20 millionth mobile phone in November 2006. The unit is producing around ten models for the domestic market. The company had also begun exports. Exports are slightly less than 30 per cent of production at the moment. Currently, Nokia phones are shipped to certain South-East Asia markets. Nokia was also keen to enter markets in West Asia and parts of Africa. The Nokia Telecom Park is spread over 210 acres and will also house 8 global component manufacturers along with the lead company. These include Salcomp, Aspocomp, Foxconn, Perlos, Laird and Jabil. Nokia partners from Finland such as Salcomp and Perlos are in the process of setting up their units in Nokia Zone. In all, it has the potential to employ 20,000 people by 2008 when it is fully operational.

Flextronics, a $16-billion global electronics manufacturing services provider, is also set to start its commercial production in its SEZ. Flextronics which would manufacture telecom equipments including handsets planned to invest $100 million over 3-5 years but invested this in the first year itself. Flextronics' Chennai industrial park will offer vertically integrated services including design, plastic injection molding, printed circuit board assembly, mechanicals and enclosure integration, distribution, logistics and repair services. By co-locating ten manufacturing and logistics operations onsite with strategic suppliers, it expects to minimize logistics costs throughout the supply chain and improves manufacturing cycle times. The Chennai operation supports manufacturing requirements of Flextronics' local and global OEM customers. Flextronics operates industrial parks in Brazil, China, Hungary, Mexico and Poland also. The production is in the pilot run stage and is already training 2500 workers. Training sessions include not only professional training but also yoga training and life-style training. Since there is mismatch between the skills required and skills available, the company is planning to design long term training programmes. The training program will be developed through a broad based consultative process and depending on the training modules completed by the workers, they will be given diplomas and degrees. World class facilities have been created for canteen and transportation. International health safety standards are fully complied with even for construction workers at the site. They are given uniform with shoes, jackets and helmets. Women are using specially designed helmets. Flextronics has claimed to employ AC buses to transport the workers. Once the plant work at full capacity employment will increase to 10000 by 2010.

India's total electronics market is expected to rise to $363 billion by 2015 from $28.2 billion in 2005, growing at a compounded annual growth rate of 29.8%.

Many argue that these companies would set up their shops even without the SEZ policy in place. However, our discussions with reliable sources revealed that most electronic manufacturers work on thin margins and manage operations on scale and efficiency to deliver products. This is because the electronics industry has extremely high rates of innovation. Short product cycles, technology obsolescence and intense competition add to the fast-pace nature and competitive pressures of the industry. SEZs by offering a possibility of clustering with component manufacturers, low cost production location, highly efficient logistics, high tax incentives, duty free imports are thus highly relevant in this industry.

Aerospace industry :

The Karnataka government is planning to set up a aerospace SEZ to reap the advantages of boom conditions in aerospace industry. The SEZ will house MROs (maintenance, repair and overhaul), units to manufacture aircraft spareparts etc. Major names in the aviation industry – such as Airbus, Bell helicopter, CFM engines, Lufthansa, Taneja Aerospace, small aircraft manufacturer ATR – have shown interest in setting up MROs in Bangalore SEZ.Airbus has already announced that it will tie up with HAL to set up MROs, costing about $300 m. MROs is the need of the hour for most of the airlines because they now have to send their planes to Singapore, Frankfurt or Toulouse for maintenance or repair. Another Aerospace SEZ focussing on MRO (maintenance, repair and overhaul) is coming up in Andhra Pradesh. The promotion of the industry will bring new technologies and promote new skills.

V. Conclusion

In India, SEZs are set up primarily with the aim of promoting broad based industrialization and economic transformation. SEZs are expected to provide a critical impetus to economic growth because they attract technology, know-how and organizational techniques in addition to financial investment. This study analyses the impact of zones on industrial development and product diversification in the Indian context. It shows that SEZs facilitated inflows of new technologies, new ideas and technologies and promoted informal R&D within SEZ units, which made a significant contribution to the process of industrial diversification in the country. The overall impact however can at best be termed 'moderate'. This could be due to the limited size of the SEZ sector in the country. Government's efforts to expand the sector did not get expected response from the entrepreneurs until recently. The poor performance of SEZs can be attributed to poor investment climate in these zones. Until about 1990, zone investment climate had been unfavourable, deterring the growth and performance of these zones. In the post 1991 period,

attempts were made to improve investment climate within the zones. However, the gradualistic approach adopted by the government did not have any significant impact on the performance of the zones. Benefits of operating in the zone vis-à-vis outside the zone did not improve significantly. Consequently the reforms could not create any dynamism in the zones. In 2000 , a major thrust was accorded to the zones. However, in the absence of any legal framework there had been uncertainly over the new policy provisions. It was after a well integrated policy framework was adopted that the government could generate hype over the creation of the zones.

It must however be noted that the government has paid too much attention to the creation of a good micro investment climate within the zones. Creation of favourable investment climate outside SEZs has received little attention. Most existing zones are encountering serious export infrastructure and governance related bottlenecks at the state level. Addressing these bottlenecks is of paramount importance. The initial hype generated in the country over SEZs may soon subside if units find it difficult to compete in the world markets due to infrastructural and governance bottlenecks outside the SEZs. Creating special enclaves and providing favourable climate within the zone is not adequate. If a country wants to succeed it has to create a good climate even outside the SEZs and address the outside SEZ production bottlenecks systematically.

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