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# 6. TEL AVIV AS A GLOBAL HIGH TECH 'HOT SPOT' - SEEDBED OR ENCLAVE?

## 6.1 INTRODUCTION

One of the most salient features of technological development and progress is its tendency to agglomeration in space. Popular accounts glorify the emergence of these new global high tech 'hot-spots' (Business Week, 1998; Newsweek, 1998) and academic studies debate their uniqueness (Bania, Eberts and Fogarty, 1993; Castells and Hall, 1994, Pouder and St. John, 1996). However, one feature that seems to have been over-looked relates to the extent to which these agglomerations are concretely linked into their regional and national economies. If they act as integral components in their regional contexts, then we would expect some form of unique linkages to exist between them and their environs, linkages which could not exist if the concentration was located elsewhere. On the other hand, if they function purely as nodes in global networks, then the local context within which they perform will act purely as a back-drop. In this kind of abstract environment, little uniqueness is related to a specific location. The external economies of the agglomeration could have developed in similar fashion somewhere else. As Krugman notes with respect to the Los Angeles economy:

> (the people of L.A.) are there because of each other: if one could uproot the whole city and move it 500 miles, the economic base would hardly be affected (Krugman 1996, p. 209).

This chapter investigates the validity of this claim with respect to the emerging global high tech 'hot-spots'. In the context of these new nodes, we can posit two divergent roles that a high tech concentration might assume in the national economy. On the one hand, it can be characterized as playing a 'seedbed' function generating technological spillovers and externality effects that percolate throughout the whole economy. In this instance there is an active interdependence of the agglomeration with the surrounding milieu, its institutions and markets. On the other hand, the high tech concentration can be perceived as an 'enclave' with all major flows (of capital, information etc) taking place with other nodes and leap-frogging the local economy. In this case, spillovers are contained within the agglomeration itself. The agglomeration is a node in a wider network with no unique ties to the surrounding area. Aside from the standard input-output linkages and regional expenditure-induced patterns of development that are likely to occur in the immediate vicinity, other major transfers (of knowledge, skills and information) will take place non-locally.

While the regional embeddedness and local synergies of the celebrated agglomerations such as Silicon Valley, Boston MA, Cambridge UK, Emilia Romagna etc. cannot be denied, can we attribute these same effects to the new global high tech hot-spots? Is it reasonable to expect similar outcomes in Hsinchu, Banagalore or Tel Aviv? Using the latter as a case study, we advance the claim that many of the emerging high tech locations function as nodes in wider networks. As such, their immediate environment is not as important an issue as the quality of linkages with more distant peer nodes.

The chapter proceeds in the following manner. After examining the reasons why technological activity is associated with spatial concentration and why this concentration is increasingly selective, we present Tel Aviv as an emerging node location for detailed examination. We use the notion 'Tel Aviv high technology' to refer to high tech activity within the Tel Aviv metropolitan area. While this in not uniformly distributed and exists either in planned clusters (science parks) or at a few select business locations in the northern sections of the metropolitan, we consciously avoid the micro-geography of this activity. Rather, we prefer to emphasize the processes at work in the formation of new, high tech agglomerations and the way in which this high tech hot-spot is uniquely linked to, or by-passes, the local economy. We adopt a similarly catholic approach to defining 'high technology'. While the definitional issue is a thorny one, all the firms and sectors surveyed here meet the criteria outlined in other recent studies (for example, Acs and Ndikumwami, 1998).

Empirical evidence of the enclave-nature of this concentration is assembled using three distinctive features of Tel Aviv high tech to highlight the argument: network formation amongst Tel Aviv firms, the decision to offer stock options abroad rather than locally and the introvert nature of Tel Aviv science parks. We conclude by outlining some of the regional policy implications of these results.

## 6.2 SPATIAL AGGLOMERATIONS; SEEDBEDS OR ENCLAVES?

The recent resurgence of interest in spatial agglomeration of technological activity has yielded a copious new body of work. The main contours of this literature can be drawn loosely around two approaches; the new economic geography school and the institutionalist school. The former, associated with the work of Blanchard and Katz (1992), David and Rosenbloom (1990), Krugman (1995) Porter (1998), and others, places spatial agglomeration squarely in the realm of externalities and increasing returns. The geographic concentration of technological activity, skilled labor and inter-related industries confers advantages that can be translated into economic growth and competitiveness. While the roots of this interest are diverse (endogenous growth theory, international trade and competitive advantage), the broad message is relatively uniform: territorial proximity is an important element in economic growth and regions (or places) matter.

In attempting to translate the above dynamics into the realities of real-world, technology-based agglomerations, stress has been placed on technological spillovers, supplier networks and labor-force pooling as the main areas in which these processes operate. A wealth of evidence is available on the existence of spillover effects, the critical mass needed for them to occur, the spatial extent of their diffusion, the central role of the university in their creation and the types of economic base likely to spawn them (Anselin *et al.*, 1997; Audretsch, 1998; Feldman and Audretsch, 1999; Jaffe *et al.*, 1993; Varga, 2000). The role of localized supplier networks in creating and sustaining agglomerations and clusters of sophisticated activity has been exemplified in studies of Indiana (Rosentraub and Przybylski, 1996) and New York State (Held, 1996). Finally, labor market processes that reinforce initial concentration have been shown to exist in expanding labor markets. In high velocity markets, firms can reduce recruiting costs and acquire local human capital at low costs (Herzog and Schlottmann, 1991).

In contrast, the institutionalist school plays down the role of externalities, specialization, spillovers and transaction costs economies in the formation of agglomerations. These "fail to capture the importance of the socio-institutional context and embeddedness of regional economic development" (Martin and Sunley 1998, p. 220). As a place or a region is also a repository of local social, cultural and institutional ties, these need to be incorporated into any analysis of regional concentration (Amin, 1999). This 'social capital' and the 'untraded interdependencies' that it promotes are said to be the glue that sticks economic development to certain places and not to others (Storper, 1995). Thus the institutionalist lexicon is very different to that of the new economic geography, stressing the roles of local trust, norms and conventions, relational assets, institutional thickness, tacit knowledge and face-to face relations in contributing to the emergence of local innovative concentrations.

In applying these concepts to explaining localized agglomerations of technological activity, the stress has been on unraveling the networks that lie at the base of successful examples of fast-growth locations and illustrating how these structures are grounded in local social and institutional conventions. These processes are claimed to underpin much of the success of Silicon Valley (Saxenian, 1994) and a host of industrial districts in disparate locations such as Emilia Romagna, Baden-Wurttemburg, (Cooke, 1996) and Texas (Hansen and Echeverri-Carroll, 1997). They also lead to very clear policy prescriptions that call for public support for 'clusters' of associated industries rooted in local capabilities, intervention to assist regions to become more responsive to global trends (i.e. 'learning regions') and steps towards diversifying and 'thickening' the local institutional base.

This approach however is accepted uncritically. Its obvious policy thrust has been interpreted as a smokescreen for a "neo-mercantalist platform for special interests" (Lovering, 1999, p. 391). Other commentators point out that the emphasis and glorification of a few choice agglomerations is perceived as a form of local boosterism. In addition, there is a tendency to over-endogenize the growth of the agglomeration and the stress on the simultaneous collaboration and co-operation in these locations is the product of 'fuzzy thinking' (Markusen, 1999). Institutionalist analysis also infers regional characteristics (such as competitiveness, adaptability) on the basis of attributes of leading firms (Lovering, 1999). This is a debatable form of inductive method (for an alternative opinion, see Markusen, 1996).

It is not surprising therefore, that attempts have been made to reconcile or augment each of the perspectives. The usual approach has been through confronting the issue of spatial agglomeration from the vantage point of the new economic geography and augmenting some of its more reductionist excesses through adding insights from institutional and evolutionary economics. Recent attempts include Pinch and Henry's (1999) account of the development of the British motor sport industry and Glaeser's (1999) work on incorporating non-market interactions (flows of ideas, peer effects, social capital flows etc) in the study of urban economies.

One issue that seems to have been overlooked relates to the position of the agglomeration of technological activity within the regional or national economy. This might seem unusual, as a *sine qua non* of most of the above explanatory accounts is the territoriality of the agglomeration and the way it is grounded into a certain place.

Our interest however is not in the external economies shared by all firms and households in the agglomeration. Rather, it is concerned with just how anchored the agglomeration is to its present environment. Could a similar concentration have developed at an alternative location? How dependent are the economic functions of the agglomeration on the unique physical setting? Krugman (1996) claims that a lack of rootedness stems from the "abstractness of the modern city's economy" (p. 208). If the agglomeration could be transplanted to another site and function in the same manner we can claim that it is purely an 'enclave' in the regional or national economy. This could be the case when the concentration functions as a node in a wider network with much stronger non-local flows than local linkages. In this case, the economic functions of the agglomeration are 'abstract' and indifferent to a particular location.

On the other hand, if the agglomeration cannot function as efficiently at an alternative site, we can posit that it is playing some form of regional seedbed function. In this instance, local flows are more important than non-local links. The functions of the agglomeration are much more 'concrete' and the success of the concentration as a whole is linked in with a particular place.

One avenue for investigating this issue arises from the recent work of Ellison and Glaeser (1997, 1999). They have suggested three factors contributing to spatial agglomeration: natural resource endowment, industry spillovers and random chance. Following this approach, we can suggest that agglomerations grounded in 'concrete' functions will be those that develop initially on the basis of some form of natural physical advantage. They cannot be easily transplanted to another location and therefore serve a regional or national 'seedbed' function. In a sample of US agglomerations, Ellison and Glaeser (1999) estimate that this factor explains 20 percent of concentration.

At the other end of the spectrum are the agglomerations that develop on the basis of chance or historical accident. This hysteresis-type approach is also based on the fact that once an activity (such as high tech research or development) is 'locked-in' to one location, it also simultaneously 'locks-out' all other locations. In this random chance story, the agglomeration is based on 'abstract' economic functions, that could be equally performed anywhere. Finally, the case of technological spillovers as promoting agglomeration, occupies an intermediate position. This kind of agglomeration can give rise to both abstract economic functions which will result in an 'enclave'-type concentration or equally to concrete economic functions that would promote the emergence of a 'seedbed'-type agglomeration. Of the three possibilities, high technology agglomerations are most likely to be derived from either technological spillovers or random choice. This would seem to indicate a higher probability of their developing as enclaves rather than as anchors.

## 6.3 TEL AVIV AS A GLOBAL HIGH TECH 'HOT-SPOT'

In its quest for 'the next Silicon Valley', the popular press often engages in identifying the 'new global hot spots' (Business Week, 1998; Newsweek, 1998). While some of the locations that turn up on these listings are hardly surprising (Boston MA, Cambridge UK), less obvious locations such as Bangalore, Hsinchu and Tel Aviv also appear consistently. These are all emerging node locations linked in one way or another to global networks. Following the argument presented above, we contend that they function as high tech enclaves within their regional economies. Most of their qualitative and information-rich flows are with distant peer locations. Their immediate environment is of little consequence; they could easily have cultivated their node function at an alternative location. That is why the high tech agglomeration in Bangalore for example, operates despite severe infrastructure constraints and bureaucratic bottlenecks (Fromhold-Eisebith, 1999) in a local physical environment that is hardly commensurate with a high tech 'image' (viz. cows on the street, telecommunications breakdowns, power outages and excessive transportation shortcomings). Similarly, this might explain why the Hsinchu concentration is based on imported skilled labor who function as 'weekday migrants' living in spartan accommodation during the week and returning home to Taipei at weekends. This enclave is largely removed from the environment in which it is located (Castells and Hall, 1994). In both instances, the agglomeration functions as a node economy tied into global networks. Most important linkages are with distant peer nodes and the immediate physical environment is of secondary consequence. Due to the 'abstractness' of the economic function of the agglomeration, the context or setting is not crucial. As suggested earlier, if the agglomeration could be preserved and 'replanted' elsewhere, it would probably function in a very similar manner.

A similar argument is advanced for Tel Aviv. The abstractness of the Tel Aviv concentration to the regional economy is manifest in other ways and will be examined below. With over 1,000 firms employing 50,000 workers, the Tel Aviv metropolitan concentration is Israel's premier center of high technology. Much of this development is relatively recent. It has been fuelled throughout the 1990's by synergetic relationships between the military establishment (especially the Israeli Army's Central Unit for Data Processing), local industry and the presence of research and design centers of the major US multinationals. The demonstration effect of highly visible fast-growth start-ups, foreign currency and trade liberalization, growing exposure to global business practice and the availability of US and local venture capital funds have together created the infrastructure for innovation. Much of the aforementioned interaction has been Tel Aviv-based: the location of the fast growth start-ups, the army computer center, most of the venture capital funds and much of the US multinational presence. It should also be noted that the country's two other satellite high tech centers (in Haifa and Jerusalem) are less than one hour's drive from Tel Aviv. So for all intents and purposes, a sizeable part of Israel's high technology activity is contained within one spatial labor market. Israel's high tech economy is largely synonymous with the Tel Aviv economy.

The Israeli high tech economy is firmly grounded in the Silicon Valley mold. Start-ups, venture capital funds and the globalization of capital and assets markets are the motors behind this model of high tech development and these have combined with local institutions (universities, defense establishment) in order to fuel this growth. In addition, much of this activity is double-pronged: much Israeli high tech has a parallel presence in the US. A popular route involves setting up a company in the US (invariably Silicon Valley) in order to understand market demand. Following that, a design and production team is assembled in Israel (invariably in Tel Aviv). Thus much of the Tel Aviv high tech boom of the 1990's relates to companies that may not officially be classified as Israeli companies. They are registered in the US in order to give local clients the perception of dealing with a local company, to beat high tax rates and arcane merger laws in Israel and to avoid capital gains problems related to distributing stock options to Israeli employees (Haaretz, 2000).

One indication of the 'gold rush' character of Israel's high tech development over the last decade is the magnitude of capital raised abroad by Israeli high tech firms. In 1993, private Israeli firms raised capital (shares and debentures) to the order of $4.3b. Of this, 87 percent ($3.76b) was raised as offerings on the local Tel Aviv stock exchange and 13 percent ($.54b) as IPO's abroad. By 1999, these volumes had been reversed. Of the $4.97b raised through public offerings, $3.34b (67 percent) was raised on foreign exchanges (about $ 2.5b in stock issues) and only $1.63 b (33 percent) was raised locally (Bank of Israel, 2000). Most of this reversal was led by high tech firms in the electronics, communications and software sectors. Over the period 1992-1998 they accounted annually for between 62 percent and 95 percent of all capital raised abroad. In view of the fact that some Israeli high tech companies are registered abroad (as noted above), these figures are likely to be an under-estimate by a further $1.4b. Local financial conditions and the local stock exchange would thus seem to be marginal to the high tech boom.

Further underscoring this point is the structure of venture capital investments in Israel. Prior to 1990 there was no venture capital industry in Israel. In 1991, venture capital investments in Israel summed to $58m. By 1999, there were 80 funds operating locally, of which 75 percent were local Israeli companies while the other 25 percent were foreign funds active in Israel. These funds raised close to $1.5b for private firms in 1999 and an accumulated sum of close to $4b since 1991.This figure doubled in 2000 but the worldwide recession saw it half again in 2001. Forty three percent of the capital raised in 1999 was raised by the Israeli-managed funds. The remainder came from foreign-managed operations and an estimated 85-95 percent of all venture capital investments in Israel are from foreign sources (Bank of Israel, 2000).

These facts serve to further highlight the way local high technology by-passes the local economy. First, local companies choose to register abroad with all the distortionary effects that this implies. Foreign investments in these companies are not registered as part of the Israeli economy, Israeli venture capital investments in these companies are registered as 'capital exports' and the operations of these companies in the local economy is registered as 'foreign activity'. This also has implications for national accounts causing biases in macro indicators of growth, employment and tax revenues. Second, local high technology firms tend to go public abroad rather than locally. Third, local venture capital funds are heavily capitalized by sources from abroad. Thus, the high tech 'gold rush' of the 1990's has developed in a bubble, parallel and sometimes incidental, to developments in the local economy.

The question now arises whether the development of Tel Aviv as a high tech hot-spot has also resulted in the development of an 'enclave' economy with all major flows taking place outside the local economy? If the high technology agglomeration functions as a node in a network, then the chances of it being embedded in the region are considerably diminished. High tech enclaves may be 'locked-in' to a few select locations but their markets, business horizons and aspirations are often elsewhere. While they feed off local labor markets and perhaps local information channels, we argue that their effect on regional or national economies should not be over-stated. High tech 'hot spots' may be highly visible image-builders for the region or even the nation, but their local effect might be simply to stress the gap between them and the rest of the economy.

We illustrate this argument by looking at the Tel Aviv high tech agglomeration. To embellish our argument that the Tel Aviv high tech economy is simply a node in a wider network with terms of reference much wider than the regional or national economy (see Chapter 4), we draw on both qualitative and quantitative evidence. The former refers to the process of network formation between firms in Tel Aviv and Silicon Valley. This stresses the growing importance of network interactivity and the concomitant decreasing importance of spatial proximity in network formation. The latter is investigated via two issues. The first relates to the decision of local Israeli high tech firms to go public abroad rather than on the Tel Aviv stock exchange. The second addresses the introvert nature of Tel Aviv science parks. The desire of new, small high tech firms to go public abroad and to agglomerate on high cost, high profile science parks is interpreted as the result of a conscious 'signaling' strategy that again has increasingly less to do with local conditions.

## 6.4 NETWORK FORMATION IN TEL AVIV HIGH TECH FIRMS

In this section we outline some theoretic insights relating to network formation and the role of distance in this process. We then illustrate these ideas on the basis of qualitative interview evidence culled from both our own interviews with senior executives of high tech firms in the Tel Aviv metropolitan area and secondary evidence from other studies.

At the outset we should note that hierarchies have been the mainstay of models in economic geography. Central place theory, location theory, the theory of the firm, core/periphery relationships etc. all assume the underlying existence of a structured hierarchy. However, when faced with network forms of organization this pattern often breaks down (Powell, 1990). Networks do not operate according to the simple principles of proximity and distance-decay. They can tie disparate nodes (places and firms) together despite barriers of distance. Some studies even show that certain types of networks are most efficient when linking distant rather than proximate neighbors (Kilkenny, 2000). Peer-to-peer contact across distances can be more important than local interactions. These benefits to distance are noted below.

While high tech concentrations may act as enclaves within their own regions, they may have wide ranging contacts and accessibility to other distant, yet similar, concentrations. Starting with some general insights of spatial interaction analysis we may assume that the contact between two nodes in a network ($C_{ij}$) is subject to some distance decay effect such that:

$$C_{ij} = K^{\alpha}_{j} \ \exp(-\beta d_{ij}) \tag{6.1}$$

where, $K^{\alpha}_{j}$ represents the attractiveness of $j$ as measured by its information or knowledge stock, $\alpha$ and $\beta$ are parameters and the negative exponential represents an impedance factor.

The contact patterns of node $i$ with the whole network ($C_i$) would be the sum of the above across all nodes $j$ and in addition would be contingent on $i$'s level of high tech or research activity ($R_i$), as follows:

$$C_i = \Sigma_j K^{\alpha}_{j} \ \exp(-\beta d_{ij}) + R_i \tag{6.2}$$

The above does not go much further than standard spatial interaction analysis. However, as Batten and Tornqvist (1990) have pointed out, a singular feature of networks is their contact frequency or 'interactivity'. There are increasing returns to network size: networks can add members and become more efficient. This contact potential needs to be included. Batten and Tornqvist (1990) suggest adding a measure ($F_{in}$) that would express all frequency contacts of node $i$ with all other networks $n$ for $Z$ agents (firms, individuals) in node $i$, such that:

$$F_{in} = Z_i \ \exp(C_{in}) \tag{6.3}$$

On this basis, a measure of node interactivity ($M_i$) can be formulated which would simply be the average of all frequency contacts, as follows:

$$M_i = (\Sigma_n F_{in}) / Z_i \tag{6.4}$$

Thus while distance may cause some fall-off in connection between nodes in a network, this is more than compensated by the interactivity and accessibility that being a member of the network provides. While face-to-face contact cannot be sustained over great physical distances, membership of a network opens up other opportunities for contact and information flows. Distance may even have a 'cushioning' effect allowing nodes to screen and mediate demands coming from other nodes. In network formations, disparate nodes are connected across space in both formal and informal modes of interaction. In contrast to the standard central place model, there is no hierarchical distance decay pattern here. Interactivity is essentially between enclaves distributed across the globe.

Applying this analytical framework to essentially qualitative interview-based data we can examine the case of network formation between Tel Aviv and Silicon Valley firms. Recent work has noted the pivotal role played by transnational flows of skilled workers between key global cities (Beaverstock, 2001). Saxenian (2002) has illustrated the importance of the international links established by Chinese and Indian entrepreneurs based in Silicon Valley, in nurturing long-distance networks linking Silicon valley into the new global high tech 'hot spots' such as Hsinchu and Bangalore. The entrepreneurs are uniquely placed for creating transnational communities and allowing local high tech nodes in their home countries to link into the global networks.

The case of Israeli entrepreneurs in Silicon Valley is very similar. A recent study has attempted to chart some of the formal and informal networks that have developed between these two economies (Autler, 2000). Overcoming distance-decay impediments, Israel's high technology sector has become increasingly integrated with that of Silicon Valley. In sectors such as semiconductor design and internet security, the presence of Silicon Valley has pervaded the development of a local indigenous capacity from the start. On a formal level, large Silicon Valley multinationals (such as National Semiconductor, Intel, 3Com, Applied Materials and Cisco Systems) have seeded the Tel Aviv cluster and the Israeli industry through setting up foreign design and fabrication centers and training local personnel in California. Silicon Valley-based venture capital funds, have been greasing the wheels of much of the internet and network security boom (although the origin of this phenomenon lies in expertise in data and network security developed in the Israeli military). Cisco for example recently decided to relocate its premises within the Tel Aviv metropolitan area, signing what the local press has labeled the 'largest rental deal ever' involving office facilities of over 40,000 sq. m. (Haaretz, 2001), equivalent to the size of a large out-of-town shopping center.

Tel Aviv-Silicon Valley networks are equally sustained by informal channels. Many Israeli entrepreneurs have a Silicon Valley chapter in their work biographies. Frequently, Israeli entrepreneurs traverse the Tel Aviv-Silicon Valley high technology route, in both directions. Some have multifarious family and social networks in Silicon Valley, comprising fellow entrepreneurs, colleagues from military units (military service is compulsory in Israel) and business associates. Others have spent long periods of employment in California culminating in their persuading US employers to open a plant or design center in Israel thereby facilitating their own return. While the establishment of US semiconductor design centers in Israel can be seen as a form of 'reverse' transfer of technology (Felsenstein, 1997), it can also serve to open up additional two-way flows of technical and market knowledge. In many cases firms with connections in both places and an established presence in either Israel (invariably Tel Aviv) or Silicon Valley, invariably end up with operations in both locations (often R&D and design in Tel Aviv, marketing and product service in the US). This demands constant email and phone exchanges and the other disadvantages that go with physical distance such as shipping delays, communications breakdowns etc. Thus part of this structure is subject to distance decay.

However, this network organization also confers certain advantages that do not decay with distance. In line with the model outlined above, we can suggest that a major benefit of network structure lies in the accessibility it affords. For Israeli companies it means exposure to markets, management practices and entrepreneurial demonstration effects that simply do not exist locally. For Silicon Valley firms, it means access to specific technological expertise, the ability to assemble relatively stable research teams, and the ability to tap into one of the last available reservoirs of R&D, to be found in small firms.

Aside from greater interactivity and accessibility we can note the cushioning effect of distance that frees designers and engineers in Israel from the daily supervision of US management and allows them to improvise and solve solutions away from the immediate pressure of the market. The 10-hour time difference between Tel Aviv and Silicon Valley also means an added benefit. Clients' problems in California can be downloaded in Tel Aviv and solved before the start of the next working day in the US.

The spatial agglomeration that characterizes the development of the high technology node serves to mediate some of the excesses of distance decay. Those firms that are part of the agglomeration benefit from the external economies that it affords. However, as we have seen above, this is only one part of the network story. The fact that networks are not spatially-bound means that accessibility and interactivity are more important features of network formation than spatial proximity. Formal and informal linkages transcend the confines of distance. This implies that high technology concentrations grounded in network formation may be irrelevant to the needs of regional development. Aside from the standard employment and expenditure induced impacts that they generate locally, all other spillover effects that they might create (flows of information, technology and the like) may be realized in places other than the local economy. In fact, the conspicuous nature of these enclaves and the lifestyles and living standards of those linked into them, may simply serve to highlight the gap they are creating with the rest of the economy.

## 6.5 TEL AVIV HIGH TECH AND GLOBAL CAPITAL MARKETS: THE DECISION TO TRADE ABROAD

The hypothesis advanced here relates to 'signaling' behavior of firms located in the new high tech, hot-spots and the secondary importance of location when trying to break into global networks. One way of breaking into global networks is through foreign investment. For high technology firms in Israel two options exist. The first is the more traditional route of mergers and acquisitions with global corporations which were valued as approximately $2bn in 1999 (Bank of Israel, 2000). A second point of entry is via initial public offerings (IPO's) abroad. This is a strategy that Israeli high tech firms have increasingly adopted, using stock issues on the NASDAQ market as a route to global networks (see Chapter 4).

The NASDAQ market is market popular with non-US firms looking to go public in the US. Due to it's electronic, floor-less structure, it has lower listing fees than the other stock exchanges and is also the main market for small high technology companies looking to raise capital in sectors such as information technology, telecommunications, biotechnology, pharmaceuticals, finance and insurance. As such, it is the main source of stock-market capital for Israeli high tech firms. In mid 1998 it had more foreign-based firms listed (453) than either the NYSE (364) and AMEX (65) markets. The market value of these companies ($4481 bn) however, was less than that of NYSE ($5776 bn) but way ahead of other international financial centers such as London ($1989 bn), Paris ($ 1414 bn) and Frankfurt ($1067 bn) (NASDAQ, 1998).

Of the 307 foreign companies with shares actually traded on NASDAQ (the other 150 companies raise capital through ADR's - American Depository Receipts), more than half (165) are Canadian. The second largest presence after the Canadian firms are the Israeli high tech companies with a further 20 percent (66 companies). All but two of these are Tel Aviv-based and all the Tel Aviv companies are engaged in high tech activities. The total number of Tel Aviv firms is more than the sum total of all other foreign firms combined; the Netherlands for example, has 17 companies and the United Kingdom, 13.

The approach adopted here is to estimate the determinants of Tel Aviv firms being traded abroad. Ostensibly, this is an inherently spatial question that poses a choice between different locational alternatives: Tel Aviv versus New York (or no IPO issues at all). Tel Aviv is the location of the local stock exchange and New York is the location of the target exchange (NASDAQ) for Israeli firms seeking to raise capital abroad. However, for two reasons, this is less of a spatial choice issue than might be imagined at first glance. First, due to the floor-less nature of the trading in New York, the question is not really a choice between two distinct alternatives but rather relates to the choice of trading in Tel Aviv versus 'somewhere else'. In this particular case, the preferred 'somewhere else' for high tech firms happens to be New York but it could quite easily be some other alternative.

Second, while Israeli high technology activity is increasingly agglomerated in the Tel Aviv metropolitan area, the importance of this location in the present story is solely as context. While nearly all the firms trading abroad are Tel Aviv-based, the presence of a Tel Aviv high tech agglomeration is not treated as an active factor in the decision-making process. The characteristics of the metropolitan area, its labor force etc. are not taken as influencing the behavior of the high tech firm. Rather they are back-drop in which the scene is set. Had the context been some other spatial agglomeration (Haifa, for example), we would expect the same behavioral forces to be present. In both these instances breaking into global networks through IPO's has very little to do with both the location of the place of offering and with the location of the firm wanting to go public.

Instead, trading abroad is interpreted here as an active strategy consciously pursed by firms in high-risk sectors where market visibility is paramount. New high technology companies that are largely unknown in the market will issue offerings abroad as a 'signaling' strategy (Blass and Yafeh, 2001). This way they indicate to markets and investors that they should be taken seriously. The main focus of interest here is the motive for investing abroad, rather than the performance-based measures resulting from this decision. We are looking to provide some support for the hypothesis relating to the ‘enclave’ nature of the Tel Aviv high tech economy and the way in which global capital markets and global networks serve to further bolster this image.

### *6.5.1 Data and Analysis*

The main sources of data for this analysis are company prospecti submitted to the Tel Aviv stock exchange, Dun and Bradstreet data from the 1997 Duns Disc, company data that is available on-line at the NASDAQ website, the Tel Aviv Stock exchange directory and the Standard and Poor’s directory for publicly traded firms (1998). Together, these sources yielded cross-sectional information on the following firm characteristics: sales, number of employees, industry description, ownership structure, location of main markets, exports as a percentage of revenues and percentage equity being offered.

In total, we managed to assemble data on over 60 Tel Aviv high tech companies traded abroad and another 20 that are traded locally. The former also includes a small number who are traded both locally and abroad. We matched this population with a further sample of high tech firms that are not publicly traded. This control group comprises a further 70 firms matched on the basis of size and revenue with very large (over 2000 employees and / or over $350m sales) and very small firms (less than 50 employees and $10m) excluded. The final data set therefore contains over 140 observations (high technology firms of similar size and sales volume), roughly half of which are traded (mainly in New York).

Due to data limitations, this empirical analysis is based on a limited selection of indicators. In terms of the characteristics of the high technology firm, size is measured by the number of employees and the volume of sales. The firm’s experience and level of establishment is measured by age in years. Market characteristics are characterized by volume of exports and their geographic destination and by the firms leading SIC area. This was divided into the following high technology sub-areas: software, communications, electronics, biotechnology, and robotics.

In order to answer the basic question, just how different are firms that issue stock from those that do not?, we run a series of difference of mean tests on the main explanatory variables. The firms are stratified into three categories: non traded, traded locally and traded abroad (Table 6.1). The results would imply that in terms of firm size (employees and sales) and vintage, those firms traded abroad would seem to be younger but also larger than those not traded abroad. It would also seem that firms trading abroad have more sales than those traded locally, although a question of causality here remains unanswered: do they have a higher sales volume and therefore seek capital abroad, or is it because they have raised capital abroad that their sales volume is larger? While the differences of means for exports, also seem to indicate a clear distinction between those traded abroad and the others, it should be noted that the many missing values on this variable, could lead to misleading conclusions.

*Table 6.1 Difference of means test: Tel Aviv high tech firms, non-traded, traded locally and traded abroad*

| | Means | | | |
|---|---|---|---|---|
| *Variable* | *Non-Traded* | *Traded Locally* | *Traded Abroad* | *F-statistic* |
| Employees | 197 | 272 | 399 | 3.1* |
| Age (Yrs.) | 12.1 | 24.1 | 14.3 | 15.5** |
| Sales ($m) | 23.1 | 11.1 | 83.0 | 7.2** |
| Exports ($m) | 34.1 | 5.0 | 96.9 | 2.0 |

* Significant at the p<.05 level.
** Significant at the p<.001 level.

An examination of the markets of the high technology firms is revealing (Table 6.2). These data refers to only the high tech firms that are traded either locally or abroad. The average exports for all firms shows a much 'smoother' picture than in reality. As noted above, the average sales volume for a firm traded abroad in $83 m and this is significantly larger than the sales volume of either firms traded locally or firms not traded at all.

For our purposes however, it is more instructive to examine the geographic pattern of sales. Total sales volume in 1998 summed to nearly $5 billion. While on average, the market seems to be divided equally across North America and Europe, the sector distribution shows that this is not the case. Software exports are dominated by the US (internet and multi-media firms) while communications firms seem to be more oriented to the European market. This pattern also describes the relative advantages of the US and Europe in the global markets for these different sectors. Other electronics (such as medical devices), biotechnology and robotics are much more marginally represented amongst the high tech firms that issue stock and this of course is also represented in sales patterns.

As anticipated, the size of the local market, seems to be irrelevant to the global markets of these high technology companies. Across all sub-sectors, local sales are way below those to foreign markets and would seem on average, to be marginal to the stock-issuers product sales patterns. Of course, some of the local competitive advantage in software and electronics may have initially stemmed from locally-driven demand (e.g. from the defense sector and from public procurement contracts) but this is not reflected in the present pattern of sales and their destinations.

*Table 6.2 Product sales by geographic destination (traded firms only)*

| | Total Sales (1998) (M $) | Destination: N. America Tot. | Avg. | Europe Tot. | Avg. | Far East Tot. | Avg. | Local Tot. | Avg. |
|---|---|---|---|---|---|---|---|---|---|
| *All High Tech Firms* | 4,970 | 1,068 | 13.7 | 1,117 | 14.3 | 274 | 3.5 | 175 | 2.2 |
| *Software* | 1,760 | 464 | 11.5 | 316 | 7.8 | 130 | 3.2 | 72 | 1.7 |
| *Communications* | 1,448 | 260 | 16.2 | 340 | 21.2 | 68 | 4.4 | 34 | 2.6 |
| *Electronics* | 275 | 55 | 4.2 | 14 | 1.1 | 23 | 1.7 | 21 | 1.6 |

### *6.5.2 Method and Results*

The estimation procedure involves analytic testing of a statistical model that will predict the probability of trading abroad as a function of firm characteristics, especially size, age and market structure (leading high tech product, destination of sales).We look at the behavioral determinants of this choice rather than the economic outcomes (share performances at the two locations etc.). The binary nature of the dependent variables (traded / non-traded and traded abroad / traded locally) necessitates a logit estimation as follows:

The probability that firm (*i*) will trade abroad is expressed as:

$$(i) = 1/1 + \exp\,(B_0 + B_1X_1 + \ldots B_n\,X_n) \qquad (6.5)$$

This is a non-linear model parallel to the general utility model:

$$P_{(i)} = [exp\ V_i] \,/\, [\sum_{i=1}^{n} \exp\,(V_i)] \qquad (6.6)$$

where:
$P_{(i)}$ = the probability of firm *i* being traded abroad
$V_i$ = vector of characteristics of the firm and it's market
$N$ = the number of options available

To estimate the model, we assume that $V_i$ is a linear function of the independent variables such that $Vi = B'X_i$ , where $X_i$ represents that characteristics of the firm and its market. These can be decomposed into firms attributes (essentially age and size, $x_{ik}$) and market attributes (product and product destination, $y_{im}$). Taking the natural log of (6.1) we get the equation in a form operative for estimation;

$$ln\{[P_{(i)}] \,/\, [1\text{-}P_{(i)}]\} = \Sigma_k\alpha_k\,(x_{ik}) + \Sigma_m\delta_m\,(y_{im}) \qquad (6.7)$$

In order to analyze trading abroad as a form of strategic behavior, we define three basic decisions that face the high tech firm:

1. At the outset, there is the basic decision to issue a public offering. We can estimate the probability of being traded as a function of the two sets of characteristics outlined above.
2. A variant on this decision is the issue of whether to go abroad to seek funds or to do something else (i.e. not to issue stock or to issue stock locally).
3. Once one of the above two decisions has been made, a further decision is necessary, provided the outcome is the decision to trade abroad. This involves the decision regarding the location of the stock issue: on a local exchange (Tel Aviv) or a foreign exchange (New York - NASDAQ).

These decisions are all binary choices and call for estimations based on logit-modeling. To fully appreciate the decision processes involved, decision 1 (above) needs to be contrasted with decision 3 and similarly, decision 2 needs to be compared with decision 3. The analytical results presented below (Table 6.3) are structured according to this sequence. Model 1 presents the determinants of decision 1 and similarly for Models 2 and 3.

*Table 6.3 Estimates of the probability of Tel Aviv high tech firms (1) being traded , (2) being traded abroad and (3) being traded in New York*

| *Variable* | *Model 1* | *Model 2* | *Model 3* |
|---|---|---|---|
| Constant | -1.329** | -.835 | 2.046* |
| | (.437)[2] | (.495) | (1.012) |
| AGE (yrs) | .070** | -.059* | -.195** |
| | (.026) | (.035) | (.067) |
| | [.055][3] | [ .042] | [.059] |
| SALES ($m) | .00008* | .0002** | .0005* |
| | (.00004) | (.0006) | (.0002) |
| | [.001] | [.004] | [.004] |
| SOFTWARE & COMMS. | .707 | .373** | 1.622 |
| (OTHER)[1] | (.470) | (.555) | (1.242) |
| | [ .114] | [ .054] | [.100] |
| n | 114 | 114 | 53 |
| Means, Dep. Var. | .55 | .47 | .73 |
| -2x log likelihood | 157.4 | 138.9 | 69.1 |
| $\chi^2$ values for model/d.f. | 20.1 / 3** | 28.7/3** | 33.9/3** |
| Percentage correctly predicted | 70.2 | 77.2 | 84.9 |

* Logit coefficient significant at p<.05 level
** Logit coefficient significant at p<.001 level
1. Dummy Variable; reference group in parenthesis
2. Standard Errors in parenthesis.
3. $\Delta P$; probability change estimated at the mean, for a unit change in the independent variable. For derivation, see Chapter 4 (Note 1).

As can be seen from Table 6.3, the probability of a high tech firm being traded (versus the alternative option of not being traded, (Model 1), is positively related to firm age and size (both factors are statistically significant). In terms of market characteristics, data constraints allowed us only the use of a dummy variable indicating whether the firm's main SIC was software or communications. This dummy has the expected sign but is not significant. Thus it would seem that larger and older firms are more likely to be traded. The $\Delta P$ values (elasticities at the mean) enable us to interpret the logit coefficients in probabalistic terms. From Table 6.3 we can see that a unit change in age, increases the average probability of being trading by over 5 percent. Similarly a unit change in sales (a \$10m increase in sales) means that the average probability of being traded rises by 1 percent.

Once the firm decides to trade publicly the next decision is where to issue the public offering (New York versus Tel Aviv, Model 3). Comparing the results of Model 1 with Model 3, reveals that in this decision, the probability of issuing in New York is this time *negatively* related to firm age and positively related to firm size (both coefficients are significant). Thus the newer the firm and the higher its sales volume the more likely it will be to raise capital on the New York Stock exchange. Again, type of market displays the 'correct' sign but the result is not statistically significant. The elasticities at the mean are also slightly higher than in Model 1 and the model correctly predicts a higher proportion of cases than the previous model.

As noted above, another way of looking at the decision making process involves estimating the probability of trading abroad (versus being traded locally or not being traded altogether), in the first instance (Model 2), and then comparing these results with the decision relating to New York versus Tel Aviv. As can be seen from Table 6.3, the younger the firm, the greater its sales volume and the more it is oriented to software/communications the greater the probability it will decide to raise capital abroad. All three independent variables are statistically significant and all display the 'correct' signs. The $\Delta P$ values for the logit coefficients indicate that an unit increase in age decreases the average probability of being traded abroad by over 4 percent. An increase in sales of \$10m increases the chances at the mean by 1 percentage point and a categorical change in product specialization from some 'other' category to software/communications, increases the probability at the average by over 5 percent.

Once the probabilities of the firm raising capital abroad (versus the alternatives of being traded locally or not being traded abroad at all) have been established, the firm then has to decide where to be traded. In this decision choice, the alternative to being traded abroad is raising capital locally (Model 3) Therefore, it is instructive to compare these estimations of Model 2 with the narrower decision-choice facing the firm as estimated in Model 3. The results show that the coefficients are consistent across both models, although the sector coefficient is insignificant in the model predicting raising capital in New York (Model 3).

The results show smaller firms with higher sales volumes and an orientation to software and communications are more likely to undertake public offerings abroad, than other firms. On the other hand, larger and older high tech firms, are more likely to go public. By implication, the results presented here therefore seem to suggest that smaller firms that go public abroad are looking for more than just raising capital. Otherwise they would go public locally.

The hypothesis presented in this section is that the utility gained from a public offering abroad, results in improved positioning and signaling. This generates a public profile for a high tech firm with little proven track record and acts as a point of entry into global networks. This further underscores the irrelevance of the local context faced with global capital and assets markets. The local economy acts as a spring-board or setting, but no more than that. Despite a flourishing local stock exchange and a plethora of local venture capital funds, Tel Aviv's small high tech firms would seem to look a NASDAQ offering as more than an instrument for raising capital.

## 6.6 THE INTROVERT NATURE OF TEL AVIV'S SCIENCE PARKS

The case of Science Parks adds a further example to our hypothesis as to the enclave nature of the spatial agglomerations. As planned concentrations of technological activity, their role is open to various interpretations. They can be viewed as purely real estate initiatives, as vehicles for promoting and diffusing innovation and as instruments for regional growth. Public policy rhetoric has widely espoused them as fostering innovation and promoting interaction with local universities However, the empirical evidence supporting these conjectures is rather thin. Studies of innovation levels and linkages to universities have found little difference between on and off-park firms (Westhead and Storey, 1995; Westhead, 1997) and have failed to establish conclusive evidence of park-induced local employment growth (Shearmur and Doloreux, 2000).

Our hypothesis is that the real estate role of the science park over-shadows that of fostering innovation or promoting local economic growth. Firms are prepared to pay a premium in the form of high rents for science park location, but that it not due to the information flows or technological spillovers that they promote. Rather, we have a further case of location acting as a 'signal', akin to the case of issuing stock abroad. Being located on a prestigious science park may be of symbolic importance for new firms that want to be taken seriously but have no proven track record or market presence.

To test this proposition we undertake a two-stage analysis. First, we observe whether the 'classic' profile of a firm founded by an academic entrepreneur and with intensive links to a local university, in fact leads to greater innovation levels. Then, we analyze whether the archetypal high tech firms (firm with high levels of innovation, entrepreneur with R&D background) have any greater propensity to agglomerate on science parks than off them. We report evidence resulting from an empirical survey of 162 high technology firms in Israel (Felsenstein, 2000), 110 firms located on one of Israel's three major science parks in either Tel Aviv or Jerusalem and a further 50 firms serving as a control group of similar ,off-park, high tech companies. The survey responses provide categorical data on (a) firm characteristics (location on/off science park, innovation level (high/low), intensity of connection to a local university (high/low) and (b) entrepreneur/manager characteristics educational level (PhD/below PhD) and work experience (R&D/production and sales). To analyze the data and test multi-dimensional contingency relationships we use log-linear modeling (multi-dimensional $\chi^2$). This involves predicting the log of the frequencies in each cell as a function of the values of the various combinations of categorical variables and the interactive affects between them.

A reduced form (main effects) model is fitted for the two sets of relationships outlined above. The first (Table 6.4), tests the relationship between the firm innovation level (*I*), interaction with a university (*U*) and the educational background of the entrepreneur/manager (*E*). The second (Table 6.5), tests the relationship was between the innovation level of the firm (*I*), location on the science park (*L*) and the prior work experience of the entrepreneur/manager (W).

Table 6.4 presents the results of a three-way cross tabulation of the variables in a log-linear equation. Taking the natural log of all the terms makes the equation linear and the table shows the various combinations of factors that lead to innovation. While education and university linkage are significant in their own rights, for our purposes the interaction effects are of more interest. Although the second-order interaction effect between university interaction and education level is significant this combination does not necessarily lead to more innovative activity. The E*I relationship is not significant, but was forced into the model. The third-order interaction (E*I*U) is also not significant. All this would seem to indicate that that successful commercial innovation is not necessarily tied to academic education or university linkage.

*Table 6.4 Inter-relationships between education, university interaction and innovation*

$$\ln(M_{ijk}) = \ln(\alpha) + \underset{(30.09/1)}{\ln(\gamma E_i)} + \underset{(7.51/1)}{\ln(\gamma U_j)} + \underset{(9.39/1)}{\ln(\gamma I_k)} + \underset{(1.96/1)}{\ln(\gamma EI_{ik})} + \underset{(5.44/1)}{\ln(\gamma EU_{ij})}$$

($i,j,k$ = 1,0)

likelihood ratio $\chi^2$ value for model = 4.64 (p=.0106/2)

where:

($M_{ijk}$) = the expected cell frequency, $\alpha$ = overall mean of the log of the expected cell frequencies, $\gamma E_i$ = effect attributable to the *i*th category of education, $\gamma U_j$ = effect attributable to the *j*th category of university interaction, $\gamma I_k$ = effect attributable to the *k*th category of innovation level, $\gamma EI_{ik}$ = effect attributable to the interaction between the *i*th category of education and the *k*th category of innovation level and $\gamma EU_{ij}$ = effect attributable to the interaction between the *i*th category of education and the *j*th category of university interaction. Figures in parentheses are chi-square statistics and degrees of freedom, all significant at the $p<0.05$ level except for the $\gamma EI_{ik}$ term that was forced into the model.

We next test for ‘seedbed’ effects of a science park location (Table 6.5). If physical proximity is really important for creating linkages, interactions and information flows, then we would expect to find more innovative firms founded by entrepreneurs with research backgrounds, opting to locate in these planned agglomerations. We therefore test for the inter-relationships between science park location (*L*), innovation level (*I*) and work background of the entrepreneur/manager (*W*).

*Table 6.5 Inter-relationships between, work experience, innovation level and science park location*

$$\ln(M_{ijk}) = \ln\alpha + \ln(\gamma W_i) + \ln(\gamma I_j) + \ln(\gamma WI_{ij}) + \ln(\gamma WIL_{ijk})$$

(18.18/1) (8.53/1) (4.54/1) (8.14/1)

($i,j,k = 1,0$)
likelihood ratio $\chi^2$ value for model = 5.76 (p=.0461/3)

where:
$\ln(M_{ijk})$ = the expected cell frequency, $\ln\alpha$ = overall mean of the log of the expected cell frequencies, $\gamma W_i$ = effect attributable to the *i*th category of work background, $\gamma I_j$ = effect attributable to the *j*th category of innovation level, $\gamma WI_{ij}$ = effect attributable to the interaction between the *i*th category of work experience and the *j*th category of innovation and $\gamma WIL_{ijk}$ = effect attributable to the third-order interaction between the *i*th category of work background, the *j*th category of innovation and the *k*th category of location. Figures in parentheses are chi-square statistics and degrees of freedom, all significant at the $p<0.05$ level.

The results show that only one second-order and one third-order interaction term are significant. Both these terms express the interaction effects of work background with innovation (W*I). The effect of location (L) only shows up in one three-way interaction. All the two-way interactions including location are not significant and even the direct effect of science park location by itself is not included in the model.

These results do not provide any support for the science park agglomeration acting as a seedbed. They seem to suggest that innovation is not contingent on the agglomerative conditions offered by the science park. The attractiveness of the science park location (as evidenced by the rents it collects) must therefore be due to something else rather than technological spillovers and information flows. If it does not promote any more innovative activity than an off-park location, it is hardly fulfilling an anchoring function. Our (untested) hypothesis is that the popularity of science park 'enclaves' is as much due to the prestige effects that they confer as to any innovative edge. In this respect, science parks revert to more life-like proportions as planned, real estate-driven concentrations whose success is often driven by the image-creating skills of property developers.

## 6.7 CONCLUSIONS

We have presented both qualitative and quantitative evidence to buttress the case that some of the new global high tech hot spots are functioning as high tech 'enclaves'. Arguably, the Tel Aviv story could represent a particularly idiosyncratic case: a highly skilled entrepreneurial society, with social and business connections worldwide, a developed scientific and military research infrastructure, liberal public support for technological activity and a miniscule local and regional market. All this would seem to work in favor of the emergence of a node-type economy linked into other similar and distant locations. However, many of these conditions patently do not exist with respect to other new high technology agglomerations, such as Bangalore and Hsinchu, that seem to be developing in a similar fashion.

The evidence therefore seems to suggest that emerging node locations may not foster unique linkages with their surrounding environment. In some ways they will be detached from what is going on around them. The economies of scale and spillovers afforded by spatial concentration are internalized within the agglomeration itself and do not percolate to the wider economy. This is not to say that the standard inter-sectoral (input-output) linkages are not generated by these agglomerations or that they have no impact in generating expenditure-induced growth. As major regional employment concentrations they cannot fail to create an aggregate local and regional income impact. However, the argument advanced here relates to the development of *unique* linkages locally that cannot be replicated elsewhere. On this count, we have not found much supporting evidence.

Bearing in mind the existence of these standard economic impacts, the regional development implications of the enclave economy may not be as bleak, as they might appear at first sight. Some economic impact will always 'trickle down' to the region or national economy, if only through the multiplier process, the tax system and the expenditure patterns of local workers. However, perhaps the least-encouraging aspect of the enclave economy relates to the distributional and equity impacts of this growth. In Israel, inequality in income distribution rose consistently over the 1990's, coinciding with the high tech boom. The Gini coefficient rose nationally from .46 in 1985 to .53 in 1997. Even after discounting direct taxes and government transfers there was still a rise from .32 to .36 over this period (Ben Shachar and Helpman, 2000). Furthermore, these figures are very likely to under-estimate the true inequalities as they are based on salaried workers only (excluding the self-employed) and do not include income from capital such as savings, stocks and inheritances.

It would evidently seem that large segments of the national population are not enjoying the fruits of the digital dividend. In fact, the high visibility of the Tel Aviv technological enclave may just serve to underscore the differences between it and the rest of the economy. High tech agglomerations that are not uniquely linked to their regional and national economies, that are comprised of firms qualitatively linked with other nodes and that coalesce around local firms registered and traded abroad, are visible symbols of the locational abstractness of the high tech economy. Juxtaposing them with the rest of the economy highlights the existence of a digital divide. In this instance, the physical agglomeration of the technology 'haves', serves to reiterate that this divide is not just social and technological, but spatial as well.

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