

**FOREIGN ACQUISITIONS AND R&D LEVERAGE IN HIGH TECH
INDUSTRIES OF PERIPHERAL ECONOMIES: LESSONS AND POLICY
ISSUES FROM THE ISRAELI EXPERIENCE**

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*This paper, which is based on a previous paper by the authors (Teubal & Avnimelech 2001), will be published in *International Journal of Technology Management*, Interscience Publishers, 2003, *forthcoming*. Thanks to Alon Gayego, Cristiano Antonelli, Ludovico DiBaggio, Dan Gelvan, Stephen Klepper, Patrick Lerena, Ruediger Wink and to an anonymous referee for their comments and suggestions.

CONTENTS

OBJECTIVES	3-11
1. RESEARCH QUESTIONS AND THEORETICAL FRAMEWORK	
2. SUCCESSFUL GROWTH PROFILES IN 'DATA SECURITY'-A SUMMARY	
<i>1.1 Types of Very Successful “Company Growth Profiles”</i>	
<i>1.2 Explaining Company Growth Profiles</i>	
3. MICRO-ECONOMIC ANALYSIS : POST-ACQUISITION PATTERNS	
<i>3.1 Definition and Examples</i>	
<i>3.2 Alternative Post-Acquisition Patterns</i>	
<i>3.3 Summary</i>	
4. MESO/INDUSTRY ANALYSIS: JUSTIFYING INCOMPLETE SPECIALIZATION IN PERIPHERAL 'INVENTOR' COUNTRIES	
<i>4.1 Comparative Advantage and Types of Specialization</i>	
<i>4.2 Post SU Managerial Spillovers to SU</i>	
<i>4.3 Post SU Personnel Spin-offs to SU</i>	
<i>4.4 Contributing to SU access of Complementary Assets</i>	
5. IS THE SHARE OF SU OUTPUT IN HIGH TECH TOO HIGH & WHY?	
<i>5.1 The importance of SU-related output</i>	
<i>5.2 Potential Overinvestment in SU: Risks & Externalities of Post SU</i>	
6. POLICY IMPLICATIONS	
<i>6.1 Policies Inducing the Transformation of Israel's High Tech Cluster</i>	
<i>6.1 R&D Leverage Policies</i>	

Acronyms

SS-Very Successful Companies
SU-Start Up or Start Up company
VC-Venture Capital or Venture Capital company
S&T-Science & Technology
ICT-Information & Communications Technology
AR-Algorithmic Research
CA-Computer Associates
VAR-Value Added Reseller
NDS,Memco, Security 7, Abirnet,...-Company Names
LP-Limited Partnership

OBJECTIVES

In previous work we analyzed the emergence and development of very successful companies in Israel's Data Security Sector—an important branch of Israel's Software & IT high Tech Industry (Teubal & Avnimelech 2001,2). The study was set in the background of the Data Security Industry as a whole, as it evolved (especially) during the 90s. A distinction was made between *Very Successful (SS)*, *Moderately Successful* and *'Other'* companies. Very successful companies – 4 out of the 19 comprising the sector towards the end of 1999- comprised more than 90% of the sector's sales, employment and profits. In that paper we defined 'growth profile' of a company in terms of two sets of variables: (I) phase in the company's growth (*Start Up*-were initial R&D is being undertaken, *Market Penetration*; and *Consolidation*); and (ii) major 'internationalization events' with a focus on IPO and M&A (Acquisition by a Foreign Multinational).¹ Our analysis identified a *Main Growth Profile* (3 very successful companies) characterized by a "fast IPO track"- where an IPO is undertaken shortly after the SU phase; and a *Secondary or Special Growth Profile* (1 company) characterized by a "fast M&A track".

Foreign Acquisitions of SU and post SU companies were very significant in the Data Security Area. Two (2) out of the four (4) 'Very Successful' companies mentioned above were acquired by foreign multinationals, one just after finalization of the SU (NDS) phase and a 'fast IPO track' company (Memco) which was subsequently acquired, during the Consolidation Phase. Within the 'Moderately Successful' group of companies, four (4) out of the six (6) comprising the group were also acquired—most at the end of the Start Up Phase.

These results, while specific to the Data Security sector till the second half of 1999, were not exceptional. In parallel to the growth of Israel's high tech industry during the 90s we observe a gradually increasing scope of foreign acquisitions of Israeli companies, both SU and companies beyond the SU phase (see Teubal & Avnimelech 20002 op cit). During the year 2000 alone more than 10 B\$ of foreign

¹The term used for Acquisition was M&A1 to distinguish this event from the acquisition *by* an Israeli company of another company, domestic or foreign (M&A2). We make a distinction between variables *defining* and those *explaining a company growth profile*. The latter are not systematically considered

acquisitions of Israeli high tech companies took place-an enormous amount given the size of the country and GNP (around 120 B\$); and of the same order of magnitude of high tech exports during that year.

These trends lead to our first objective –"*How much small, skill-intensive economies and their IT high tech sectors benefited from the Globalization Process during the 90s.*"? In some cases foreign acquisition of SU might have truncated their subsequent 'indigenous' development into 'Downstream' Production and Marketing (frequently acquired SU become part of an R&D Lab of the foreign company); or – when the acquisition took place at the Consolidation Phase- it might had led to cuts in non-R&D employment.

The extent of foreign acquisitions became possible with the onset of a new phase in the Globalization process which took place during the 90s: for the first time in history, very good SU *in peripheral economies* could float in the relevant Global Capital Market (Nasdaq).² Such SU are primarily involved in R&D and need not show current or past profitability. They parallel Teece's 'inventors' in his study almost 20 years ago of the role of Complementary Assets in explaining the distribution of gains from 'significant' invention (see Teece 1986). The Data Security study suggests two effects of Globalization: first, a strong stimulus to hi-tech, particularly to Start Up (SU) companies, fueled by the growth of NASDAQ's index and by the emergence of a domestic VC industry which "mediates" between such companies and Global Capital Markets; and second, a strong process of foreign Acquisition (M&A) of very good domestic companies including SU ones. This last factor raises the issue of the distribution of gains between Israel on the one hand (a 'country' populated by many SU or 'inventors') and the acquiring foreign multinationals on the other (competitors & owners of Complementary Assets who according to Teece frequently earned a large share of the social returns to invention)³. The broader issue is to find an adequate balance between SU and post-SU activity. This is a central question given the fact that the market solution-so dependent as it is on the specifics of the institutional and policy contexts- need not be adequate given

in this paper. They include company capabilities/competences; strategy; market & technology area characteristics, etc.

² The possibility of floating US high tech SU in public capital markets apparently emerged during the 70s and became more and more systematic and predictable during the 80s, especially after the crisis of 1986. Note that this possibility was, *de facto*, not systematically & reliably available to foreign SU. Our presumption about the new possibilities open to SU in general reflects the significant jump in the 90s of total IPOs in the US and in VC-backed IPOs (Gompers & Lerner 1999, p. 15)

national objectives. The framework of analysis used here to discuss this issue is an adaptation of Teece's 1986 framework to take into account the new opportunities and threats of the current phase in the Globalization Process.

The second objective of this paper (Section 5) is to suggest a number of policy implications of the analysis which might be relevant for small, skill-intensive countries or regions. Since the significant scope of foreign acquisitions of domestic companies was a consequence of the successful adaptation of Israel's high tech industry & System of Innovation during the 90s- a distinction will be made between two broad policy issues. First, *policies designed to promote high tech cluster adaptation to the new wave of Globalization* i.e. towards a system, like in Silicon Valley, populated by large numbers of SU and VC companies; second, *policies designed to enhance 'R&D Leverage' in small skill-intensive economies whose high tech clusters have adapted.* One measure of the latter is the extent by which SU companies led to Downstream Production & Marketing (Post-SU activities which are employment creating). Israel's policies belonging to the first category were successful—this is reflected both in the emergence of a distinct VC industry during 1993-5/6 and in the creation of hundreds if not thousands of SU companies (Avnimelech & Teubal 2002a). On the other hand there seemed to have been no systematic policies designed to enhance R&D Leverage. If the Data Security paper is indicative of the issues involved, the latter category of policies should be directed to exploit the possibilities open to high-quality SU to undergo a *fast IPO track*; or whenever the external and internal circumstances permit, to influence companies during the consolidation phase in their decision to continue an indigenous course rather than sell to a foreign multinational.

1. RESEARCH QUESTIONS AND THEORETICAL FRAMEWORK

Two Levels of Analysis

The first objective of this paper involves two groups of positive analytical issues which correspond to two levels of analysis: Microeconomic & Meso/Industry level (see Box 1). Both refer to IT high tech. The Microeconomic questions lead us to consider the post-Acquisition patterns of Very Successful Data Security Companies, together with some reference to other Communications Equipment/Software

³ See Teece 1986 op. cit.

companies in Israel who were likewise acquired during the 90s. The analysis is a natural extension of our analysis of successful growth profiles in Data Security. Four post-acquisition patterns were identified based on whether 'activity' has expanded or not & on whether or not acquisition has truncated significant indigenous company growth. It is clear from the analysis that some acquisitions have been extremely beneficial while others may have actually truncated a healthy indigenous growth process.

BOX 1: ASSESSING THE BENEFITS FROM FOREIGN ACQUISITIONS IN A GLOBALIZED HIGH TECH CLUSTER: LEVELS OF ANALYSIS & SPECIFIC ISSUES

<p><u>Microeconomic: Post-Acquisition Patterns</u></p> <p><i>Do Acquired Companies Move Abroad?</i></p> <p><i>Has the Foreign Acquisition led to 'lost opportunities' or 'unexploited R&D Leverage'?</i></p>
<p><u>Meso/Industry Level Issues</u></p> <p><i>Desirability of 'Incomplete Specialization' in SU-Post SU Managerial & Personnel Spin-offs to SU</i></p> <p><i>Is the Share of SU Activity in Israel(years 1999,2000) Too High?</i></p> <p><i>Determinants of the Desired Balance between SU and Post-SU('Downstream') activity</i></p>

The Meso/Industry level questions are attempts at generalizing to the whole IT high tech sector the results obtained in Data Security (both growth profiles and post-acquisition patterns). It also makes use of additional data on IT high tech Manufacturing and on the contribution of SU- related output (measurement of which has begun lately) to Israel's ICT growth and GNP growth. A major component is a theoretical discussion of Comparative Advantage SU; and of 'indirect' contributions of post SU companies (involved in Downstream Production/Marketing) to SU companies. While a full analysis of these issues is not possible at this stage sufficient theoretical and empirical reasons have been put together to surmise that Israel's high tech cluster in 1999/2000 involved too much SU activity & too little post-SU activity

relative to what could have been an 'adequate' proportion. This of course sets the stage for the last Section on Policy

Theoretical Framework

Neither analyses of Data Security companies is directly related to *Theories of the Firm* be they Neoclassical/Agency theories (Hart 1990), Contractual (Coase 1937,1988) or Evolutionary/Competences Based theories (Penrose 1959, Nelson 1962, Teece et al 1994, & Hodgson 1999, Ch IV). Nor have they been directly related to the Strategic Management Literature (Pralahad & Hammer 1990; Teece 2000). The reason seems to be that most research in these areas has not yet dealt explicitly with *Company Growth Profiles* let alone profiles which focus on 'internationalization events' of Peripheral Economies. They are partial exceptions (e.g. Cohendet & Lerenat 2000; and items in a survey by Levie & Hey, 1998). However the spirit of our work draws upon the Evolutionary/Competence, Contractual and Strategic Management Approaches particularly the concept of 'Dynamic Capabilities' (Teece op. cit). For example, the transition between the SU and Market Penetration Phases must be associated by 'sharp turns' in company strategy and its 'core capabilities'; and the post IPO strategy of successful companies with respect to the question of accessing Complementary Assets must involve a changing balance between various mechanisms: *integration* of new capabilities; strategic *alliances* and *contracting*. However, at this stage our work has only generated a platform or skeleton upon which a deeper analysis of changing competences, strategies and contracting may be erected. *The potential is thus great for fleshing out a stronger and deeper perspective of Successful Firm Growth Profiles, which in our opinion, should become an axis of future research on high tech companies.*

For the Meso/Industry level of analysis we have drawn upon two different areas in the literature. The first relates to the new opportunities for inventors or SU companies in Peripheral countries opened by the new phase in the Globalization process during the 90s. Teece's 1986 analysis of the fate of inventors who frequently are unable to obtain a return to their invention should be modified significantly to explain why Globalization has stimulated the creation of so many SU companies in Israel; and why the share of SU-related output over total IT high tech 'output' would seem to be high. The second strand of research in the literature bears upon the question 'why SU specialization in a country like Israel should be incomplete' or

alternatively, why SU should co-exist with a significant post-SU segment involved in Production/Marketing of goods (a fact which to some extent reflects the *implementation* of inventions domestically). Within this strand we focus on research done on the links between SU and *post SU companies* (our term) particularly the unintended spillovers & spin-offs from the latter to the former.

The central point to be made is that if the context presented by Teece would be true today we would not have had a high tech boom in Israel (probably not in Ireland & India either)during the 90s. His framework of analysis should be extended –in two ways. First, there are greater possibilities of obtaining a return from invention without having to accumulate or even access complementary asset: better organized markets enabling *Sale/Licensing of the Technology* by the inventor/SU(Arora et al 2001); and ***Foreign Acquisitions***(a possibility not systematically available before the 90s and not considered by Teece; but central in our analysis). Second, the possibility of accumulating such assets through *Integration* or accessing them through the *Market/Contracting* or through intermediate forms like *Alliances*—have also increased. A major reason is the recently available "systematic" opportunity for high quality SU to undertake an ***IPO***—at least in those Peripheral countries whose hi tech sectors have adapted(Israel would be one example). This paper will not analyze these new possibilities in depth-- they will be taken as given (e.g. Israel has undertaken more than 100 hi tech IPOs during the 90s see Avnimelech/Teubal 2002 op cit). From this extended framework it follows that the problem of *R&D Leverage* exists only because of the widened opportunities for SU entry in Peripheral economies. More specifically, foreign acquisitions are at one and the same time an important stimulus to SU companies and a potential cause of weak R&D leverage effects (i.e. little downstream production/marketing emerging from 'invention').

Concerning the actual/desirable share of post SU in high tech we follow Chesbrough 1998 and others who have raised the issue of an 'incentives constraint' facing established/Post SU companies. This limits the possibility of providing high powered incentives *to in-house inventors*. If 'systemic conditions' are right (like in the US Hard Disk Drive industry, and presumably in Israel)-this would lead to personnel spin-offs from Post-SU to SU companies where the latter develop the new technology/product. There could also be management spin-offs from post SU companies, or these companies might leverage their management/marketing capabilities to access Complementary Assets for SU. The importance of this for SU

intensive high tech industries like that in Israel is a result from the essential qualities of 'management know how', an intangible asset which is not systematically traded in markets, particularly in Peripheral Economies. According to Teece 2000, this is the basis for sustained competitive advantages now a day, an essential component of 'Dynamic Capabilities' relevant for both the SU and post SU stages of successful company growth. There is evidence that such indirect, unintended spillovers of post SU to SU were present both in Data Security and elsewhere. Their existence gives weight to the argument in favor of achieving a 'balance' between SU activity and post SU activity(a major Meso/Industry level analytical issue).

2. SUCCESSFUL GROWTH PROFILES IN 'DATA SECURITY'-A SUMMARY⁴

The background to the emergence of a successful Data Security sector in Israel (a part of the Software industry)has been extensively discussed elsewhere (Teubal/Avnimlech 2002). It involves the process of Globalization of the last two decades of the millennium and the emergence in Israel of a new type of High Tech Cluster spearheaded by 'product' Software and high tech Communications equipment/software. Our purpose here is to present a summary of 'very successful' company growth profiles, since this will set the stage for a discussion of post-acquisition patterns (Section 3) and Meso/Industry Level implications(Sections 4 & 5).

2.1 Types of SS Company Growth Profiles

Figure 1 presents stylized *Growth Profiles* for the four SS companies which reflects, *grosso modo*, their history. They are obtained by superimposing a *small number of 'internationalization events'* on the three phases of company growth: SU (Phase 1); Market Penetration(Phase 2); and Consolidation(Phase 3). Central among these are an IPO(followed by Memco, Aladdin and Check Point) or its M&A1 alternative (followed by NDS) early during Phase 2; and either Indigenous Consolidation (followed by Check Point) or Acquisition by a Foreign Company (Memco) in Phase 3⁵. From this we build a *Main, 'Early IPO Track', Profile* which covers three

⁴ Mostly taken from Teubal/Avnimelech 2002, op. cit.

⁵Additional research on a larger universe of very successful IT (rather than specifically Data Security) companies would lead us to finer distinctions among profiles. These would be based on the superimposition of additional information on the phase sequence e.g. Strategic Partnerships, etc.

companies: Check Point, Memco and Aladdin; and a *Special, 'Early M&A Track' Profile* -followed by NDS.

Other Characteristics of "Early IPO track"

- Successful Development and Initial Marketing in Phase 1 opens up the possibility of undertaking an IPO early in Phase 2.
- The IPO becomes an important component of the Market Penetration Strategy of that phase

The casework underlying the analysis shows that a minimum level of "achievement is required for an IPO⁶ and that this IPO takes place *early* in Phase 2 rather than as part of company "consolidation". Moreover, an early IPO opens up a number of possibilities for Phases 2 and 3. Thus all three companies following this course have undertaken acquisitions of both local and foreign companies subsequent to this event (M&A2). Finally, success in the US 'capital market' (Nasdaq) in raising capital and through indirect effects such as enhanced visibility/reputation is almost a *sine-qua-non condition* for generating links with important customers or for entering into fruitful Strategic Partnerships. It may be fairly concluded that undertaking an IPO is an element of firm strategy rather than simply a method of 'exiting' for VC and other investors⁷.

Special Case (the "early M&A1 track")

The main feature here is foreign acquisition of the local company--M&A1-- already at the end of Phase 1 or beginning of Phase 2. A major function to be served is Market Penetration and therefore this action is in effect a substitute for an IPO in relation to assuring access to Complementary Assets.⁸

General Remarks

- IPO and M&A1 are *substitutes* in the early Market Penetration Phase of Very Successful Companies. Both are capital market transactions which enhance access to Complementary Assets. They differ in that the IPO both directly and indirectly enables the company to accumulated or transact for the acquisition of such assets

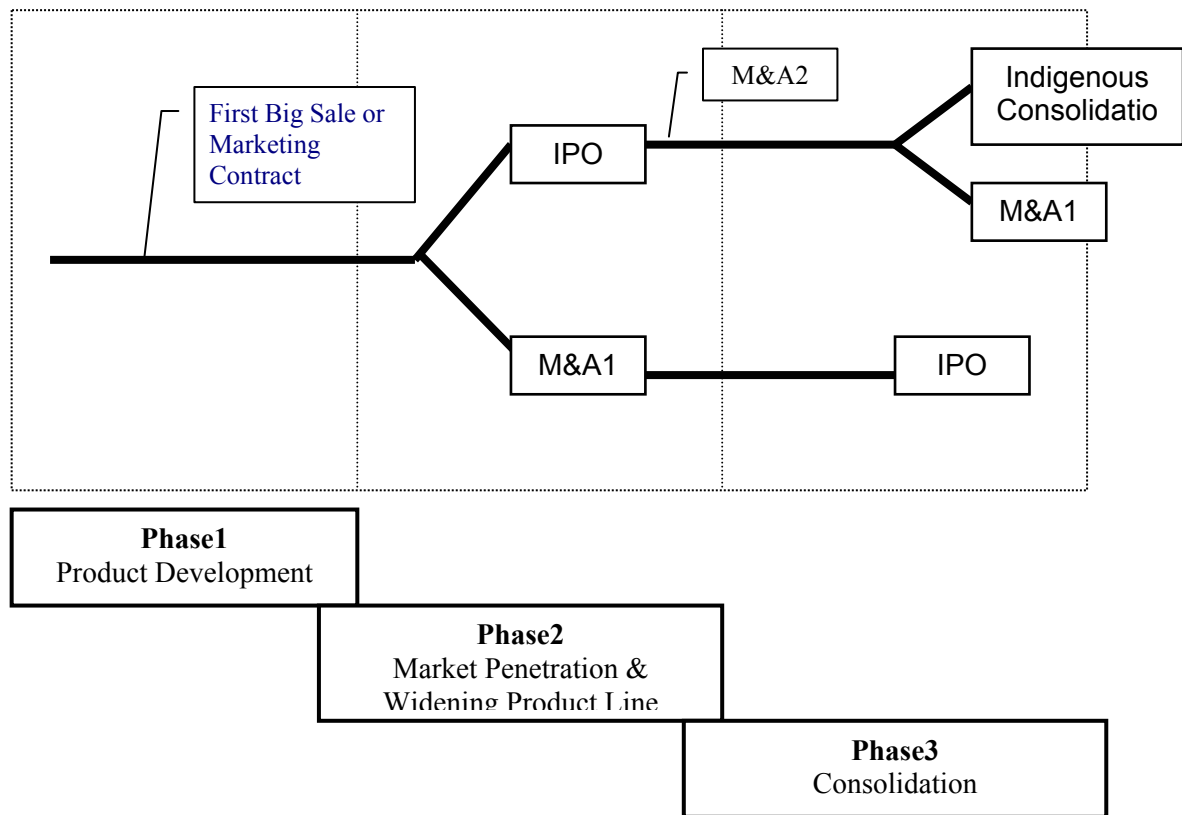
⁶ It seems that some sales are inescapable as proof that there exist customers who see the product as satisfying their needs (things might differ as regards to this point with respect to Internet Companies). The minimum level also includes some consensus about the 'quality/potential' of the innovation and of the team conducting the firm.

⁷This has been analyzed in Teubal et al 2000 op. Cit but is not reported here due to lack of space.

⁸Like with Sky TV who acquired NDS, the acquiring company might be an important client and/or might possess important marketing capabilities.

(or services from such assets) while M&A enables 'exiting' by inventors/investors without having to accumulate or access these assets through the market.

Figure 1: Growth Profiles of Very Successful Enterprises



Notation

M&A2 represents acquisition of other companies (domestic or Foreign) **by** the Israeli company. M&A1 is acquisition of the domestic company by a foreign company.

- IPO in NASDAQ seemed to be a *necessary condition* for a company's products to succeed in the US market without losing company identity i.e. while remaining *indigenous*. If the accrual of important benefits from 'invention' in Peripheral Inventor Country ('Israel') require that the invention, at least in part, be implemented domestically then the Data Security experience suggests that an IPO in the Global Capital Market is at least necessary if not crucial⁹.
- There are two *patterns of foreign acquisition* of a SS Data Security companies(M&A1):during market penetration (early Phase 2 of the *Special Profile*) or company consolidation (Phase 3, *Main Growth Profile*).
- IPO and M&A1 could be *complementary*. In the *Main Sequence* the IPO precedes the M&A1 without foreclosing a future Acquisition (case of Memco). In the *Special Case* either there is no IPO at all or the IPO comes after M&A1 (NDS was acquired in the early 90s and underwent an IPO in late 1999).

2.2 Explaining Company Growth Profiles

BOX 2: FACTORS EXPLAINING A 'FAST IPO TRACK'¹⁰

	Firm Strategy and Founders' Preferences	Existence of Experienced VCs	Country Hi Tech Reputation	Level of Nasdaq Index
NDS(acquired In 1991)	<i>NA (or neutral)</i>	<i>No</i>	<i>No</i>	<i>Low</i>
Aladdin (1993)	<i>Strongly Positive</i>	<i>(almost)No</i>	<i>Fair</i>	<i>Fair/Good</i>
Memco (1996)	<i>NA or neutral</i>	<i>Yes</i>	<i>Strong</i>	<i>Very Good</i>
CheckPoint	<i>Strongly</i>	<i>Yes</i>	<i>Strong</i>	<i>Very Good</i>

⁹ In Data Security an IPO in Nasdaq was important for two reasons: first, higher prospects of raising sufficient capital; second, the US market visibility/reputation generated (The US market was the main market for very successful companies). The issue arises as to which global capital market should be accessed for 'market penetration' purposes when the main market of the company lies in Europe rather than the US.

¹⁰Yes, Strong, Good indicate a favorable effect of the variable on a 'Fast IPO Track'; No, Weak, Low imply a favorable effect of the variable on the alternative 'Fast M&A Track'. The 'Fast IPO Track' of Aladdin should be reinterpreted to mean 'after its re-orientation towards the US Market in the first half of the 90s'.

(1996)	Positive			
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The box summarizes some of the factors explaining choice of a 'Fast IPO Track' company growth profile (Aladdin, Memco and CheckPoint) or alternatively, choice of a 'Fast M&A Track' profile by Memco. Further explanations can be found in Teubal & Avnimelech 2002 op. cit.

3. MICROECONOMIC ANALYSIS OF POST-ACQUISITION PATTERNS

3.1 Definition and Examples

An 'Post-Acquisition Pattern' is defined by (I)the phase of Acquisition of the Company(SU or post SU); (ii) changes in activity(R&D and non R&D)which followed acquisition and (iii) extent of loss of 'R&D Leverage'¹¹. Post- Acquisition may involve expansion or reduction of R&D activities in the country; & expansion or reduction of non-R&D activities. The most important effect of Acquisition of a very good company might not be the *actual change* in activity compared to what existed before but whether the *potential* expansion of activity has materialized or not. Since existing activity and assets of Israeli Start Up companies are R&D/technology, and -at least for very good companies- these could have created an opportunity for successful market penetration & growth, future post SU expansion could be viewed as a result of "R&D leveraging". This might be influenced by whether a company is acquired or not; and if it was acquired, on its post-acquisition status e.g. whether it is part of a Division or a Subsidiary with significant autonomy; and by other factors¹². In what

¹¹ Post- acquisition associated with expansion or contraction of activity is not the only factor affecting the "Social Desirability" of such Acquisition. The acquisition might reduce the level of activity of the previously independent domestic company, but there might not have been an indigenous growth alternative (e.g. due to Industry Consolidation and associated company 'shakeout', such an alternative would fail). Still it would be important to know which Acquisition Patterns led to reductions in activity; and which to increases-as a first step in trying to answer this broader question.

¹² For example a post SU company with excellent technology and a market leader in its field may have had excellent sales, employment and profit growth prospects prior to its Acquisition (Strong "R&D Leverage" Potential). Suppose that in the aftermath of the acquisition the new Division or Subsidiary is transformed into an R&D Lab of the acquiring foreign multinational; and that all of its non-R&D functions and personnel are eliminated. Under these conditions there might be a significant *Loss* in 'R&D Leverage' since, absent the acquisition, the company would have continued to grow. The economy would have lost a market leader (or important market player) with a much stronger and *varied* pattern of activity expansion and asset accumulation relative to what occurred after the company was acquired.

follows we will give two examples –one where foreign acquisition did not affect R&D leverage; and another where it probably did.¹³

NDS(Pattern 1-see below): Acquisition at SU phase led to fully owned subsidiary and to expansion of both R&D and non R&D activity

NDS (News Digital Systems) Technologies Israel Ltd. was founded in 1988 by Cryptography experts from the Weizmann Institute of Science who, after searching for applications of their knowledge, solved the basic access & security problem of “Satellite Pay TV”. Shortly after the company received a contract from the Sky TV channel which both enhanced the reputation of the team and provided it resources to continue their work. Negotiations with News Corporation followed, and the company was finally acquired in 1991. What is now NDS Technologies Israel Ltd. became a fully owned subsidiary of the News group and maintained considerable autonomy. In 1996 it became part of (or was acquired by) NDS—a UK company also belonging to News Corporation. This apparently enhanced links with the Parent company and its management; and, despite some loss in flexibility and freedom of action, the company is still independent in day to day management

The Israeli subsidiary is in charge of Data Security of the products of the company while the Parent Company deals with Data Compression and with Transmission of the Information (including servers, cables, antennae, satellites, etc). There are two basic products-DBS(Data Broadcasting Satellite—seemingly the product which began in 1989) and, since 1997, DBS(Data Broadcasting Network—which are networks with TVs and computers which enable all forms of information and interactive TV). The big advantage of becoming a subsidiary of News was in marketing and sales (NDS Israel's first clients came from the parent); enhanced Reputation; and use of the marketing/distribution network which was common to all companies of News Corp. The disadvantage was loss of freedom and of flexibility, and some problem in selling products to companies which compete with the Parent

Throughout the 90s the company maintained its innovativeness and achieved a number of firsts: in achieving a Satellite TV solution; in using smartcards for Pay TV; solution to Digital TV; etc. Employment grew very fast from a few tens to 120 employees in 1995, and 400 employees in 1999. Most of the employed personnel are University graduates involved in R&D whose budget in 1998 was 30 M \$. Sales also

¹³ They exemplify, respectively, Patterns 1 & 4. See below

experienced an enormous expansion from 70 M \$ in 1995 to 400 M \$ in 1999. The expansion of activity of NDS Technologies Israel Ltd has had a lot to do with the freedom of action it has enjoyed under News Corporation.

Conclusion: The ‘early acquisition’ of NDS took place when the new Silicon Valley model was not yet established in Israel: the country’s High Tech Reputation was not yet established; and there was not yet a well developed Venture Capital industry. Therefore, the alternative option (to acquisition) of undertaking an IPO was quite improbable; and with it the possibility of growing and becoming a large indigenous company (a similar Israeli company in the mid 90s would have had a greater chance of growing compared to NDS's chance in the early 90s). Moreover, NDS after its acquisition significantly expanded both its domestic employment (particularly R&D) and sales. On both counts we conclude that in all likelihood the acquisition of NDS did not entail a significant ‘cost’ in terms of a Lost “R&D Leverage”.

Memco(Pattern 4-see below): Acquisition after IPO and after successful Market Penetration .Dismantling of non R&D activities while R&D could increase or decrease.

When MEMCO was purchased in 1998 it was not a SU company but a company that had done well far beyond the SU phase. By then it had an excellent product in the server-security market; significant sales/marketing organization (most of the 120 employees in the US), OEM agreements with Platinum (who also held over 10% of ownership) and Tivoli-a wholly owned subsidiary of IBM; strong links with VARs and System integrators like EDS; alliances with other leading providers of security products in Israel and abroad(CheckPoint, CyberSafe, Eagle Eye and Security Dynamics); and annual sales of a few tens of millions of dollars (55 M\$ in 1998). It also successfully underwent an IPO in 1996 the proceeds of which enabled it to acquire two security companies (Abirnet in Israel and a US company) and to develop its multi-pronged, successful, marketing strategy. The IPO and its effects were instrumental in the rapid growth of revenues, profits and employment of the company during 1997 and 1998. During this period Memco also generated significant spillovers to the Israel’s high tech cluster.

Memco’s marketing capabilities were dismantled after acquisition by Platinum. Computer Associates(CA) -who subsequently acquired Platinum-, transformed MEMCO into an R&D Lab. The company did not become a Subsidiary

but a Division (or part of a Division) of CA. There seemed to have been at most only moderate increase in the R&D performed in Israel.

Conclusion from Memco's case

Memco's case probably epitomizes the likelihood of *strong loss of potential R&D leverage effect* resulting from Acquisition- seemingly a clear case of 'truncation' of an indigenous growth path. Interestingly, there probably was no great reduction in the level of activity in Israel (which was mostly R&D activity prior to acquisition)—the reductions that took place concerned the company's US-based staff which was involved in marketing, sales and customer support. It was clear, also from the information supplied by Memco, that they had a good chance of growing into a large indigenous Data Security Company.¹⁴ What distinguishes this case from those of Pattern 2 is that a significant amount of R&D leverage had already occurred in terms of actual sales and growth of Israeli based personnel (150, mostly in R&D); that the company had already undertaken a successful IPO; and that it had a leading position in what supposed to become a very important market within the Data Security area¹⁵.

A major aspect of the loss to the Israeli hi tech cluster is what seemingly seems to be loss of direct contact with clients (this is now done by CA staff). This effect cannot be measured by the reduction in *domestic* non-R&D activity and personnel since most such employees were, prior to acquisition, based in the US. The Israeli based team probably benefited considerably from the intense two way interaction taking place then between marketing and R&D. This process would, a

¹⁴For example, a research note of the Gartner Group of January 1998 entitled "The Unix Root Protection Market" which surveys the various offerings of the field states "...The most exciting offering is Memco Software's SeOS, now offered directly by Memco as well as Platinum Technology as AutoSecure and by IBM as Tivoli Access Control Activity (TACF). Memco also has the most effective worldwide channel up to date, with resellers in Europe and Asia as well as an original equipment manufacturer channel...Other platform vendors will include Memco's technology in their Unix operating systems by year 1999 (0.8 probability)." This statement was made only a few months before Platinum's acquisition of Memco. The report also compares Memco's product with the offer of CA (the latter acquired Platinum in 1999). The report states:" Computer Associates International's CA-Unicenter offers a form of root protection as well; however customers have reported failures in their Unix Systems resulting from Unicenter's attempt to intercept access requests for data or programs.....". In the same line a 1998 report of Aberdeen Group on Memco emphasizes the role of independent software suppliers in providing "security solutions capable of supporting the heterogeneous environments the enterprise relies on to run the business". It adds that Memco "...known for supplying cross platform security solutions that deliver effective protection at the operating environment level...has established a leadership position in the security market".

¹⁵This distinguishes it from Pattern 3 and AR's experience. AR at the time of acquisition had successfully penetrated the European market but not yet the US market(which, with the oncoming of the Internet, was becoming the main Data Security Market).

priori, seem to be much weaker after Acquisition, although this may very much depend on the acquiror's intra-firm information flows.

From a broader high tech cluster perspective the acquisition of Memco must have changed the pattern or structure of asset accumulation of the company (or of what was then the company)making it more specialized in R&D/technological assets and less specialized in market and client-related assets (less contacts with clients, weaker identifiable reputation effects; fewer direct links to VARs and System Integrators; etc).

3.2 Post-Acquisition Patterns

The following table summarizes the main Acquisition Patterns. It also includes a short description of how various firms fit into them.¹⁶ We identify four (4) Acquisition Patterns –Patterns 1 & 2 for the Acquisition during the SU phase or shortly thereafter; and Patterns 3 & 4 involving Acquisition in the Post SU phase. Pattern 1 involves significant expansion of R&D personnel after Acquisition while Pattern 4 implies significant reductions in non-R&D personnel (with only some changes in R&D personnel after Acquisition). NDS belongs to Pattern 1 and Memco to Pattern 4. Our Analysis also covers in detail the case of Algorithmic Research (AR), a Moderately Successful Data Security company who fits into Pattern 3 where no significant changes in personnel seemed to have occurred after Acquisition.

BOX 3- FOUR POST ACQUISITION PATTENRS

Pattern#	Phase of Acquisition	Change in R&D	Change in non-R&D	Loss in R&D Leverage? (Examples)
<i>1</i>	<i>SU phase</i>	++	+	<i>No(NDS)</i>
<i>2</i>	<i>SU phase</i>	<i>small</i>	<i>small</i>	<i>Mostly No(Security 7*,Abirnet*); a small number probably Yes(Libit)</i>
<i>3</i>	<i>Post SU</i>	<i>+(or 0)</i>	<i>+(or 0)</i>	<i>Some Yes (probably AR*); others No</i>

¹⁶Data Security Companies are indicated by *, the remainder being Communications Equipment/ (other)Software companies. The data and qualitative information are valid till the end of the year 2000.

4	<i>Post SU (SS company)</i>	<i>-(or 0)</i>	<i>--</i>	<i>Yes-several cases (Memco*) No-with industry consolidation (Galileo)</i>

* non Data Security, IT companies; ++ (--) means strong increase(reduction)

We now summarize the remaining two patterns of foreign acquisition of domestic companies shown in the box above(patterns 2 & 3).

Pattern 2: Acquisition at SU phase and retention of R&D in Israel at prior or expanded levels (firm did not undertake significant non-R&D activities prior to nor after Acquisition).

This is the most common pattern of acquisition in Israel during the 90s(presumably tens of cases).While most companies might be strong technologically speaking, very little can be said about their pre- acquisition potential for post SU growth. The reason for this is absence of significant sales and no real proof of potential to undergo an IPO, etc. *Only a small number of firms in this category had such a potential and would implement it in the absence of an acquisition.* Another point of this pattern is that acquisition did not in general lead to expansion of non-R&D activity, and in most cases, to only minor expansion in R&D.

Pattern 3: Acquisition during Post SU phase with maintenance or increase of both R&D and non-R&D activities.

Compared to the previous pattern there is not only proof of technological prowess prior to acquisition but also a measure of success in the market place, and in company post SU growth(though less than that of Pattern 4). Thus “R&D Leverage Potential” presumably existed for a fraction of companies. On the other hand, acquisition did not always truncate (or substantially truncate) the company’s development, in some case the contrary would be the case. Therefore a clear conclusion about “R&D Leverage Potential” *Loss* is not possible without looking at the specifics of each case. For example, it could be argued that Algorithmic Research would have survived and grown even in the absence of Cylink’s 1997 acquisition. This suggests that a measure of R&D Leverage *Loss* existed (despite some post

acquisition expansion)¹⁷. Other cases within this category might give other answers, however.

Different patterns of post-acquisition organization & control may induce stronger or weaker expansion of domestic activities and, whenever relevant, of sales of the follow-up unit within the foreign multinational. For example, significant autonomy in decision making could be retained so long as the new Division (or Subsidiary) continues to be profitable (AR & RadNet); and this may assure continued post Acquisition growth and 'R&D Leverage'. However things can change abruptly and ultimate decision making—including the decision as to where decisions will be taken-- will be made abroad. The net effect could go both ways.

3.3 Summary

The change in the level of (domestic) activity is only one impact brought about by the acquisition of a successful company. A related and potentially more significant impact is the likely 'Loss of R&D Leverage'. Moreover, overall 'Social' impact of an acquisition should go beyond loss or gain of potential R&D Leverage. It should, absent the acquisition, also consider spillovers from company growth (these indirect effects are discussed in the next section)

A loss in potential "R&D Leverage" is strongly likely when a domestic company has a reasonable alternative to acquisition through continued dominance of (or important player status in) a growing market. In the case of Memco (post-acquisition Pattern 4), the company was a leader in its field in the US market, thanks to its excellent product and to the successful IPO completed two years before acquisition. When such an alternative does not exist or is much less likely (e.g. due to difficulty in accessing Complementary Assets or to a strong process of Industry Consolidation) the loss of 'Potential R&D Leverage' is less likely and the impact of the acquisition (excluding spillovers) will be more faithfully measured by changes in actual activity. This is the case of NDS (Pattern 1) where the SU phase was completed prior to the process of Globalization & Evolution of the High Tech Cluster which made 'R&D Leverage' a more realistic possibility¹⁸.

¹⁷ This conjecture is reinforced by the fact that in the year 2001 AR acquired back its own shares from Cylink, thereby effectively becoming again an indigenous company.

¹⁸ Non acquisition of NDS might have led to the classical case of inadequate 'inventor' performance due to difficulty in accessing 'Complementary Assets' (Teece op.cit 1986). This would reflect an 'appropriability constraint' to innovation and SU companies (mentioned by Chesbrough 1999), one

The major open question were more research is urgently needed concerns *early* SU acquisitions of ‘good’ Israeli SU during the 90s(Pattern 2). Some of them might have become a Memco (before its acquisition) or even better, but Downstream Activity potential will probably not materialize in the aftermath of their acquisition by a foreign company. In a minority of cases acquisition would loss in 'R&D Leverage'. It is very difficult to identify these cases let alone to measure the loss.

4. MESO/INDUSTRY LEVEL ANALYSIS: WHY SU ‘INCOMPLETE SPECIALIZATION’ IN ‘INVENTOR COUNTRIES’ MAY BE JUSTIFIED

4.1 Determinants and Indicators/Implications of Comparative Advantage

Given that the pattern of foreign acquisitions of SU companies found in the Data Security Area was prevalent elsewhere in Israel’s IT high tech industry during the 90s (especially second half, see Avnimelech/Teubal 2002 op cit)-the question arises as to the extent of ‘SU specialization’ which could be justified from a economy-wide or “Social” perspective. Since specialization is a normal consequence of free International Trade Israel’s abundance of Engineering and R&D-related Skills imply a Comparative Advantage in creating innovative SU companies that eventually would be acquired by foreign companies. It also means a Comparative *Disadvantage* in further downstream development of these innovations since this seemingly would require a larger domestic market, a different set of factor proportions and new organizational & managerial forms (e.g. large firms, hierarchical rather than creative organizations, etc). Moreover in a world with strong Increasing Returns for post SU activity (as implied by Teece 2000, Chapter 1) , Israel’s small domestic market would further strengthen its Comparative Advantage in high tech SU companies. Box 1 lists the Determinants of a Comparative Advantage in SU in small skill-intensive economies/regions as well as some indicators that this in fact prevails in Israel.

BOX 4: COMPARATIVE ADVANTAGE IN SU (viz a viz post SU high tech)

Determinants

- *Large Pool of S&T Skills and Good Research Universities*
- *Small Domestic Market*

resulting from failure to access Complementary Assets rather than from technological/R&D externalities

<ul style="list-style-type: none"> • <i>Distance from important Export Markets</i> • <i>Proven Entrepreneurship</i> • <i>Limited Experience with Large, Civilian Oriented, post SU companies</i>
<p><i>Indicators(Israel)</i></p> <ul style="list-style-type: none"> • <i>Large Numbers of SU (absolute & normalized by population, etc)</i> • <i>Reasonable or 'Low' rate of SU failure</i>

Despite the Comparative Advantage in SU one could argue that one does need some companies to grow to the point of being able to sell into the final markets, and that while the creation of SU for subsequent sale can be beneficial, the creation of indigenous companies that also operate in such final markets(possibly becoming multinational themselves) could also, for *direct & indirect reasons*, be quite desirable¹⁹. Justification of “Incomplete Specialization” (and some implications in terms of types of companies populating the high tech cluster) are shown in Box 2.

Concerning Israel’s Comparative advantage in SU, a study of entrepreneurship locates Israel quite high in a the set of countries surveyed (Global Entrepreneurship Monitor 1999). This is independently confirmed by the existence of thousands of SU companies in this country²⁰. Concerning SU failure- this of course depends on many factors e.g. on NASDAQ. However, conventional wisdom till mid ‘99 was that the rate of failure of Israeli SU was lower than in the US (9 out of 10 there; much less here).

A number of ‘direct’ conditions for Incomplete SU Specialization (Box 2 above) also seem to hold in Israel. Thus in several areas Israel has had a singular technology & the Army has undoubtedly been a sophisticated user & a source of such technologies as well; e.g. (probably) CheckPoint's Firewall. Also, the 'product' Software industry were Israel is strong requires fewer ‘Complementary Assets’ than other, production intensive areas; while access to such assets has been made easier by Israeli companies' opportunities to float in NASDAQ-a result of Globalization and a

¹⁹Alternatively, having a Comparative Advantage in SU companies does not negate the possibility of having or developing Competitive Advantages in some post SU , even Global, companies.

²⁰There are no systematic figures on SU nor are there good definitions. The Office of the Chief Scientist defines a SU company as “a young company whose first and main activity is R&D”. Every year it provides assistance to several hundred SU, 300 SU companies during 1997(all programs). The stock of SU companies in Israel is commonly stated to have been ‘several thousands’ towards the year 2000 (see Avnimelech/Teubal op cit for some figures). It is doubtful, however, that all of these are

well developed VC industry (which made it easier for SU companies to undertake such operation). Finally we should also mention that the growth of 'large' wireless and other communication companies are beginning to represent important sources of demand for new technologies and products.

BOX 5: JUSTIFYING ‘INCOMPLETE SPECIALIZATION’ IN SU AND IMPLICATIONS FOR SU/POST-SU COMPANIES

<p><u>Determinants of Incomplete Specialization in SU</u></p> <ol style="list-style-type: none"> 1. <i>Availability/Existence <u>in some areas</u></i> [direct determinant] <ul style="list-style-type: none"> • <i>Singular Technology</i> • <i>Sophisticated Users</i> • <i>Non-Niche Market and Growing Demand</i> • <i>Large ‘Technology Demand’ Companies</i> (e.g. in Communications) 2. <i>Easier Access to Complementary Assets (new Markets; through IPOs, etc)</i> 3. <i>Unintended Management Know-How Spillovers From Post SU</i> [indirect] 4. <i>Personnel Spillovers from Post SU Companies</i>[indirect]
<p><u>Implications</u></p> <p>Desirability of at least a measure of Post SU growth & activity—in general and in selected areas & markets. <i>This could imply existence of <u>a fraction of ‘good/sophisticated’ SU which</u></i></p> <ul style="list-style-type: none"> • <i>Follow an indigenous Post SU path (in Data Security this seemingly meant a ‘Fast IPO Track’); or</i> • <i>Are acquired in the Post SU phase (rather than during SU phase)</i>

The ‘indirect’ reasons for such a pattern were also present: Managerial Know How Spillovers & Personnel Spin-offs from Post SU companies which benefited SU. To these we turn now our attention

4.2 Management Know How Spillovers to SU

Management know-how is to a large extent an experience-based, non traded good where efficient markets do not exist. It is therefore, a major source, in present

‘high quality’ SU; and undoubtedly a fraction was founded in direct response to the Nadaq ‘bubble’ of the late 90s.

world conditions, of the Dynamic Capabilities of firms—a condition for 'sustained competitive advantage' (Teece 2000, op. Cit). The existence of Post SU companies may be important for generating high quality, very successful SU. There are several reasons for this.

- In contrast to US SU, many SU entrepreneurs in Israel and other Peripheral economies are strongly 'technologically oriented' rather than 'market oriented'; and they have the disadvantage of lying far from their main markets. This makes it more difficult to identify the right product application for their technology and to ensure a good fit between the products/technology being developed by the firm and emerging needs of the market. Moreover lack of experience means that accessing Complementary Assets is a major obstacle to growth. Management help is critical on both of these counts
- *Post SU Companies generate, directly and indirectly, unintended spillovers to SU.* For example, experienced managers may join SU companies or may join Venture Capital companies which provide management inputs to their portfolio SU thereby raising their value. Also, personal networks may lead to valuable information flow from senior managers of large companies to managers of SU companies. These mechanisms were present in the areas and firms studied^{21, 22}.

4.3 Post SU Personnel Spin-offs to SU

Chesbrough (Chesbrough 1998) suggested that the 'incentives constraint' facing large US companies— which prevents them from providing strong incentives to intra-firm inventors or entrepreneurs— frequently induces spin-offs of important managerial and engineering personnel, including to SU companies. This feature is also linked to characteristics of labor and capital markets, particularly to flexibility in

²¹We must recall here another source of Management Inputs to SU—those flowing from large Multinationals like IBM, Motorola, Intel and Digital who got established in Israel during the 70s. These were 'Greenfield' investments with unintended managerial spillovers to SU companies. Despite their important contribution, especially before the 90s or in the early 90s, they are imperfect substitutes of the management inputs provided to SU by Israeli post SU companies, especially during the second half of the 90s (for example, the latter can more readily enter into strategic alliances and marketing agreements with other domestic companies, as exemplified by the pre-acquisition behavior of Memco; and by the activities of CheckPoint—see 4.4. below)

- ²² *The identified managerial input adds value at both the SU & post SU phases.* Even for those companies who will eventually be acquired by foreign companies they may directly or indirectly facilitate the option of going public first and then selling to a foreign company rather than selling early i.e. the "fast M&A track.

the market for highly skilled personnel; and the existence of Venture Capital.²³ The incentives' constraint results from the need of maintaining a balanced incentives' structure within the company. Start up companies are not prevented from offering high powered incentives both to such managers and engineers e.g. through stock options, handsome salaries etc. In this way, top notch engineers which embody the experience and knowledge of years of research in incumbent companies may join SU companies. This has happened frequently in the US e.g. in the Hard Disk Drive Industry where IBM time and again contributed such spillovers to successful generations of SU companies This link is reinforced by Venture Capital which provides the funds, engages in headhunting and adds value in other areas .

The conditions of Israel during the 90s are similar to those described by Chesbrough as prevailing in the US as far as mobility of high level personnel, flexibility of labor markets and availability of Venture Capital are concerned. They, therefore, support our belief that post- SU companies and large indigenous companies have generated an 'Indirect Contribution' to SU creation and evolution. An additional country specific, *facilitating factor* has also been present: the existence of an Horizontal Program subsidizing bottom-up determined R&D projects in the Business Sector, without favoring particular segments nor discriminating against SU. This program has facilitated both the flows of new SU and the transfer of engineering and managerial talent from post SU/large indigenous companies to SU companies. These considerations lend additional weight to the notion that while Israel may have a comparative advantage in SU the appropriate pattern or configuration is one of 'incomplete' rather than 'complete' specialization.

4.4 Post SU Help in Accessing Complementary Assets

Teece and Chesbrough have emphasized the problems of achieving investment 'coordination' between suppliers(in our context, a SU inventor) and users/customers of new technology, where effective use of such technology requires investments in specialized complementary assets and technologies. Imperfect coordination, particularly in very competitive environments characterized by considerable uncertainty, could block access to Complementary Assets and thereby lead to low or

²³More specifically, prevalence of the limited partnership mode of organization of Venture Capital.

negative returns to inventors/SU(an 'appropriability constraint').²⁴ A major moderating factor are 'intermediate' forms of supplier-user links-forms lying between a pure market/arms-length/contractual configuration and supplier/user 'integration'. In Israel's Data Security Sector several mechanisms were in operation which represented contributions of incumbent and post SU indigenous companies to SU activity. These included: OEM agreements (e.g. Memco with a SU called Pelikan); direct investment or acquisitions of SU companies(e.g. of both Memco and CheckPoint); and CheckPoint's Standards Interface organization—OPSEC-which must have solved the coordination problems of complementary technologies for many new Data Security and other IT SU companies.

5. IS THE SHARE OF SU OUTPUT IN HIGH TECH TOO HIGH & WHY?

The presumption of a relatively highly proportion of SU versus post SU activity in Israel's high tech IT sector for 1999/2000 cannot be ultimately proved at this stage, since it would require a major research effort which combines both micro and macro analysis. There are also important data & related conceptual problems: according to the conventional way of measurement the acquisition of a SU is not regarded as an 'export' or as part of high tech output as traditionally measured (only recently have *measures of SU-output* been published). Despite these difficulties it is important to pose the issue clearly and to contribute to the informed judgment of policy makers. The above-mentioned presumption is buttressed by three sets of facts or reasons[⊗](1) Data showing that the share of SU-related output was 'high' during

²⁴Where complete independence between supplier and the buyer is the norm an innovation's adoption is coordinated through the market, with its attendant high-powered incentives and potential hazards... whoever has the best product at the right time at the right price can expect to win the customer's business. Buyers have little supplier loyalty a priori and try to design their systems to use products from many alternative suppliers. Suppliers must refrain from becoming locked into a particular customer, since it might go elsewhere in the next round of product competition. Part of the customer's decision will depend on the supplier's ability to provide the right product at the right time. However, the customer is unwilling to make any extended commitments ex ante to allow suppliers to secure the requisite complementary assets in advance. The *appropriability constraint* here can therefore be quite high, since companies that have a great product but are unable to produce and deliver it in a timely way might fail to win the business".(Chesbrough op. Cit p. 467). These considerations are consistent with Agency and Contractual Theories of the firms in Economics (e.g.Hart): under incomplete and costly contracting, 'contract renegotiations' will take place in the future, a fact which considerably enhances the uncertainty of accessing Complementary Assets through the market. The costs will be even higher when 'relationally specific investments' are required for a bilateral contract (this corresponds to the case of *Specific Complementary Assets*). The upshot is that certain types of services or inputs will not be accessible from the market. Thus, absent the possibility of *integration* SU will have to enter into Alliances/Strategic Partnerships; & local post-SU companies would be their natural partners.

those years; (2) partly due to this factor, the relatively higher risks to the economy of SU activity; & (3) unintended spillovers/spin-offs of post SU companies to SU companies (mentioned in Section 4). We now expand on the first two of these reasons.

5.1 The Quantitative Importance of "SU-output"

The 1999 share of "Advanced (IT) Sectors" in industrial employment--27%-generated only 30% of total industrial revenues²⁵. Thus 'measured' *average* revenue in this sector were only 10% higher than for Manufacturing as a whole-- despite employing 57 % of engineers and scientists and 30% of the capital stock. This could either indicate *weak "R&D Leverage"* i.e lots of skilled engineers in R&D who generated little measured revenues; or the existence of a second source of SU output--*sale of technological assets (M&A)*.

In Israel towards the end of the 90s, the above 'paradox' can be explained by the second factor—sales of 'technological assets', large foreign acquisitions of SU companies.²⁶ This is a '*stock measure*' of revenues, not considered in the statistics of Industrial Revenues nor Industrial Exports(at least till 1999). The value of such acquisitions (around 10 B \$ in 2000) was "high' relative to the merchandise exports of Advanced IT Manufacturing sectors (7521 M\$ in 1999).

5.2 Potential Overinvestment in SU: Risks & Externalities from Post SU activity

Our presumption would be further buttressed if *SU activity involves different and probably higher risks to the Economy relative to those confronting downstream, post-SU activity---* in particular a strong sensitivity to increases and decreases in the Nasdaq Index. The variability of the SU-related data of Table 1 confirms this point. It shows that SU contributed significantly and positively to Israel's GNP growth of the first three Quarters of the year 2000; and negatively and significantly during Quarter 4 (2000) & Quarter 1(2001). This data also suggests that the overall economy vulnerability depends on the share of SU versus post SU output (which was very high) or 'activity'; and on the variability of the Nasdaq index.

²⁵ "Industry in Israel-Tables and Diagrams, 1999", Ministry of Industry and Trade, Sept 2000, p.53. Advanced IT Manufacturing Sectors' include Electrical Equipment, Office Machines & Computers; Communications, Control and Medical Equipment; Electronic Equipment and Transport Equipment & Vehicles. .

is the relatively high share of Value Added in high tech industry Revenues. Another explanatory ²⁶ factor not pursued here

Whenever this factor is not sufficiently taken into account by private agents, the 'market' solution might involve *undesirably high* shares of SU activity over total IT high tech activity²⁷. This presumed 'overinvestment in SU' is reinforced by the Post SU externalities which private investors do not take into account in their decisions (managerial and personnel spillovers/spin-offs, mentioned in the previous section).

TABLE 1: CONTRIBUTION OF SU ACTIVITY TO ISRAEL'S GNP GROWTH-2000/1(five quarters)

	00/1	00/2	00/3	00/4	01/1
GNP Growth (%)	6	7	9	-10	1.75
GNP Growth Excluding SU(4%)	4	4.5	3.5	-8	4
SU Contribution-Absolute (%)	2	2.5	5.5	-2	-2.75
Relative Change in GNP growth due to SU activity	50%	56%	157%	-25 %	-69 %

Source: V. Shohat, The Marker, 29-5-01 (Approximate Figures)

Conclusions

The analysis reinforces our *presumption that the share of SU in overall IT high tech was too high in 1999/2000*. 'Too High' in two senses: a) compared to some measure of Social Desirability; b) compared to what must have happened after 2000 (e.g. the last year). If we plot the share of SU 'output' over total IT high tech output we would most probably get an upward sloping curve that peaks in the year 2000. The first stretch of the curve would reflect, among other things, the almost continued

²⁷ This may happen especially under conditions like those prevailing for a couple of years till mid 2000 where bandwagon and/or demonstration effects may prevail over the choices that investors or entrepreneurs would make in 'normal' times.

increase in the NASDAQ Index during the second half of the 90s²⁸ which has inflated the value of SU acquisitions relative to the flow value of revenues generated by IT high tech (especially in the year 2000). Under the conditions prevailing today one would expect a higher share of downstream activities (reflected in output and export flows) in total IT high tech.

The upward sloping section of the curve is confirmed by the “*IT hi-tech SU intensity*” index used in Table 2. This index is the ratio of “SU output” to “total ICT output” (or “total ICT exports”²⁹) where ICT stands for the Information & Communications Technology Sector.

TABLE 2: SHARE OF SU OUTPUT IN TOTAL ICT ACTIVITY(%)

	1990	1995	1996	1997	1998	1999	2000
SU out/ ICT output	-	4.25	7.8	8.2	13	20	43
SU out/ ICT exports	-	7.2	13	14.1	20	28	50

Source: Central Bureau of Statistics, “Development of Information and Communications Technology In The Last Decade”, 28-03-01

6. POLICY IMPLICATIONS

The 'R&D Leverage' problem (and its link with foreign Acquisitions of domestic SU) emerged as a result of the successful adaptation of Israel's System of Innovation to a new phase in the Globalization process. During the 90s a reliable mechanism for participation of high quality SU of skill-intensive Peripheral

²⁸While it is true that a lower NASDAQ Index will also negatively affect IPOs and the possibilities for indigenous, post SU, company growth, this effect is only *indirect*. Our presumption is that it will affect the SU segment more than the post-SU segment. This is a reasonable assumption although it may require further justification.

²⁹ See Central Bureau of Statistics 2001. The ICT sector is a mixed Manufacturing-Services set of sectors, defined by the OECD. It includes Electronic Components, Communications Equipment, Scientific & Industrial Process Control Equipment, Communication Services, Computer Services (including Software), R&D Services and "Start Up Output". SU output has been calculated using macro-figures of Venture Capital Investments valued by a factor which includes the average Rate of Return in Nasdaq. Needless to say this is a rough measure of SU output since it is not based on the actual value e.g. of SU acquisitions (which is the indicator previously used in this article). This fact however is immaterial to the analysis pursued here.

Economies in Global Capital Markets -either through an IPO or M&A- made its appearance. The same process which provided strong incentives to 'invention' /SU as well as to high tech in general, also created an 'R&D Leverage' problem, at least in the case of Israel.

The upshot is that the 'story of weak R&D leverage' is part of the broader story of 'emergence' of a new model of high tech—a Silicon Valley model, with lots of SU and lots of VCs. The possible lessons from Israel's experience should not be limited to what was done later to compensate for such a weakness since the extent of the problem itself and the nature of its solution would depend on the precursor policies adopted and on their impact. Moreover, this broader approach to policy may make it relevant also for regions which have not yet (but who may consider) adopted (adopting) the SU and VC intensive 'model' of high tech.

The two areas of policy to be briefly analyzed are:

1. What policies directly helped Israel's high tech industry 'adapt' to the new wave of Globalization i.e. transform or reconfigure its High Tech Cluster?
2. Given the successful impact of those policies, what additional policies have or could have been adopted to moderate the weak 'R&D leverage' effects which emerged?

The theoretical framework we adopt is the Systems/Evolutionary Perspective to Innovation and Technology Policy (ITP). An analysis of this perspective can be found in Teubal 2002. For 1 above we emphasize *general characteristics of Evolutionary Processes: Variation, Selection and Reproduction*; while our short analysis of policy area 2 will be based on other features of the above perspective.

6.1 Policies Inducing Transformation of Israel's High Tech Cluster³⁰

The new model of hi tech did not emerge in a vacuum; rather it resulted from transformation of a pre-existing Electronics industry which was largely dominated in the 70s and 80s by Military R&D. A number of background conditions and events contributed to the creation of a favorable context for the successful implementation of 'high tech cluster re-configuration' policies in 1993. The gist of the latter was a targeted

³⁰ This draws from a broader analysis in Avnimelech/Teubal 2002 op cit

program, "Yozma"³¹ which induced a process of *evolutionary 'reproduction' & VC industry "emergence"* during 1993-5/6. This in turn is associated with the onset of a cumulative process involving aspects such as: new entry into the VC industry; collective learning of SU and VC; 'cluster level' Reputation and Networking effects; and exploitation of scale economies (various aspects). Finally reference should be made to a prior process of *variation & selection* which set the stage for the above cumulative 'reproduction'³². This took place during the 1990-92 *immediate pre-emergence period*.

Box 6 below summarizes facts & events/ processes pertaining to *Background* and to the *pre-Emergence period*; the second box is a summary of Yozma program characteristics & of the *VC emergence process*.

BOX 6: SELECTED BACKGROUND CONDITIONS & PRE-EMERGENCE PERIOD

<p><i>Background Conditions(the 80s)</i></p> <ul style="list-style-type: none"> • Abundant Skills and High Quality Research Universities • An existing Electronics Industry • An Horizontal R&D Support Program • Restructuring of Military Industries • Economic Liberalization
<p><i>Pre-Emergence 'Variation' & 'Selection'</i></p> <ul style="list-style-type: none"> • <i>Policy Experimentation and Learning</i>(identifying a System Failure; the Inbal Program, institutional adaptations, learning about desirable VC organization, etc) • <i>Business Experiments</i>(how to create Israeli-US SU, SU screening-investment & IPO in Nasdaq-undertaken largely by non-formal VC organizations) • <i>Incentives Program</i>: continuation of R&D Support; Technological Incubators' Program, Magnet Program • <i>Unsatisfied Demand for VC 'services'</i>: a wave of new SU some of high quality

³¹ venture or initiative in Hebrew

³² 'Reproduction' refers to increasing the share of A selected variant (e.g. of formal VC companies with a Limited Partnership form of organization) in the overall population (e.g. of agents and organizational forms linked to the financing of SU). It therefore takes place *after* selection. Selection also winnows away existing variants generated by a prior 'variation process'(see Nelson 1995).

Many of the new SU during the late 80s and 90s were spin-offs from existing Electronics Industry, from companies and organizations involved in Defense R&D(were significant restructuring took place); or founded by returning Israelis. Continuation of the existing R&D support scheme assured these SU of at least 50 % Government subsidy for their R&D, a fact which made it easier for them to obtain finance from other sources. The other sources became increasingly available once it became clear that a subset of SU companies from Israel were very good & could undertake an IPO in Nasdaq (about 9 floated before Yozma in 1993). Returning Israelis who had been involved in the US. In companies or investment banks; and US individuals began investing in such SU. Their collective activity gave proof of the new model of SU—one oriented to global Capital Markets (IPOs in NASDAQ).

Success of Business Experiments with the new model of high tech and high tech finance, executed in the absence of a formal VC sector (only 1 or 2 VC companies operated then) *is one aspect of 'selection'* during the pre-Emergence period. The other aspect pertains to Policy makers: having identified the *Market & Systemic Failure* namely that a new method of financing innovation in Israel was required, they devoted their effort to the structuring of the new organization. The Inbal program(1992) showed the limitations of 'public' VC; while the US experience showed the positive role of the Limited Partnership(LP) form of organization. Yozma was then structured to support (in 9 out of 10 private funds supported) the LP form of organization.

Box 7 shows additional aspects of the Yozma Program; and of the cumulative process than ensued

BOX 7: YOZMA PROGRAM CHARACTERISTICS & NATURE OF THE CUMULATIVE PROCESS THAT ENSUED

Yozma Program Characteristics

- 40% Government Investment in private VC companies following the LP form of organization and possessing a reputable foreign financial organization as a limited partner
- 'Early Phase' high tech SU investments
- Incentives to the "upside"(possibility of purchasing Government's share at approx. cost)
- Total VC funds (private & public) aimed at: 200/250 M\$

- Privatization of Yozma

Cumulative Process

- Yozma promoted SU entry and VC entry (directly and indirectly)
- Foreign participants and Strategic Investors contributed indirectly through Reputation and Networking Effects
- Collective Learning-by SU, by VC and interactive learning involving both types of agents
- Exploitation of Economies of scale (both within VC organizations; within the VC industry; and within the high tech cluster as a whole)
- VC-SU Co-evolution

Yozma was a relatively unique program in the policy scene existing then. It was *'targeted'* to a specific segment of the Business Sector-VC industry (although, as mentioned, the actual targeting was preceded by Business Experiments and Policy Learning). The need to learn the VC business and the required association with reputable foreign organizations--led to a significant process of 'learning from others, reputation enhancement and networking effects'. Another important aspect was a correct assessment of the 'critical mass needs'—200/250 M\$ of which 100 M\$ came from Government sources. We believe that this scale effect was responsible for the cumulative effects that followed; and that these involved a virtuous cycle of *VC- SU co-evolution*(see components in lower part of the box above³³).

6.1 R&D Leverage Policies

No systematic policies were followed, probably because developments occurred so fast. Our discussion will cover four policy areas which are linked to four objectives of policy- *facilitation of IPOs of very good SU; direct support of 'downstream' activities; support of 'general infrastructure'; and support of Management spillovers*. Both policies that could be pursued and those actually pursued in Israel during the 90s will be indicated. We will refer both to changes in

³³ See Avnimelech/Teubal 2002 op. cit

institutions and to incentives' programs; and to some extent to general policies beyond Innovation & Technology Policy (ITP).

Facilitation of IPOs: This is a major means of favoring good SU in their attempts at chartering an indigenous growth path. In Israel the relevant policies involved or could have involved *facilitation of M&A2* (among Israeli companies, as a way of achieving critical mass for subsequent IPO); and possibly, regulatory changes in the Tel Aviv Stock Market³⁴. Mergers with other domestic companies in the same field were obstructed to some extent by *institutional/bureaucratic factors* and by *taxation issues*. Institutional-Bureaucratic factors included the need to get explicit court authorization for a merger (though this might not have been applied to local mergers), the rights of minorities in companies who received acquisition offers; and anti-trust laws. The latter tended originally to have focused on the local rather than the international market—so two companies wanting to merge would be blocked if their share of the local market was a dominant one even if their share of the world market was only a small fraction. This factor apparently became less important later on. We don't have sufficient specific information about the other institutional/bureaucratic factors; although presumably their impact was moderated towards the end of the decade. Concerning *taxation*, the issue concerned whether taxes on capital gains would be collected at the time of the exchange of shares in a domestic merger (usually a merger involved both an exchange of shares and a flow of cash) or only when shares & corresponding gains were 'realized'. Some flexibility on the part of the tax authorities was achieved towards the end of the decade but the problem still did persist.

Direct Support of Downstream Activities: Israel has an *Investment Subsidies Scheme* originally oriented to non-high tech industries but gradually becoming dominantly influenced by 'downstream' investment of high tech companies (e.g. support of Intel's greenfield investments in Israel). This scheme is *Horizontal* and focuses on the hardware component of the investment with increasing but still limited consideration of intangibles. What is missing is *Integrated Targeted Support of Downstream Activities (Selected areas only)-with a focus on SU*. 'Integrated' means

³⁴We will not deal here with the latter. An issue in the latter refers to the extent by which a local stock exchange may become a springboard for SU companies who later would float in Nasdaq. Regulatory changes might facilitate such a role.

coordinated support of physical investment, infrastructure, purchase of technology, production learning, training, engineering, etc. This kind of support is widespread in Europe and in other countries ('SME policies') but not in Israel. It would be wise to think of such a program for a small set of sectors or sub-branches of manufacturing where clear competitive advantages could be generated (e.g. in batch technologies; or in areas where strong R&D-production links exist or coordination is required). During the last years of the 90s a separate training scheme was implemented by the Ministry of Industry and Trade, but this is far from representing a component of integrated downstream support to SU. Recently the Magnet Program which is oriented to cooperative, pre-competitive R&D in Israel has been emphasizing the creation of user groups whose objective is to adapt and learn technologies brought from abroad. All these developments could contribute to fostering downstream activities of SU but no integrated policy exists yet in this area.

Support of Transportation & other General Infrastructure: This would be required to support enhanced production and marketing domestically

Support of Management and Management Spillovers from Post SU companies: This is a broad area which covers elements of infrastructure and other more direct measures. One example establishment of 'high tech programs' in some of Israel's Schools of Management. Another, 'institutional', aspect of potentially great importance has been the flexibility of Courts with respect to the re-employment of senior personnel which voluntarily resigns from incumbent companies. Following examples from Silicon Valley, existing laws were either re-interpreted or extended to enable greater mobility of such personnel, a process beneficial to SU.

SUMMARY AND CONCLUSIONS

Foreign Acquisitions of Domestic SU in Peripheral Economies are part and parcel of the process of Globalization & associated adaptation of the high tech sectors of those countries. Since in the case of Israel, there can be little doubt that Globalization favored high tech and the economy as a whole, the issue for that country (and others similar to Israel) is not "Are Acquisitions Good or Bad". Rather, the relevant question is whether some acquisitions have reduced employment domestically, whether this was avoidable, and whether a Potential R&D Leverage of

very good SU has been truncated or not. If this was the case this would have affected downstream production and marketing and the emergence of indigenous, high tech companies.

It should be noted that since Acquisitions, their scope and impact, are very sensitive to the underlying institutional & policy framework there is no a priori reason for the 'market solution' to be optimal or adequate to the country. It may very well be that large scale acquisitions of promising SU companies would lead to non-insignificant curtailing of potential post SU activity and to longer term dynamic inefficiencies of high tech clusters.

This paper has attempted an analysis of this issue at two levels—a microeconomic and a meso/industry level. At the microeconomic level we analyzed the post acquisition patterns of the three most important foreign acquisitions of very & moderately successful Data Security Companies (out of a total of 6 such companies). The result indicates a mixed outcome—in one case the Acquisition brought large benefits to the domestic high tech cluster and to the economy; in another significant reductions in employment took place as well as a likelihood that additional 'R&D Leverage Potential' was unrealized; with no clear impact (neither positive nor negative) was registered for the remaining case. The analysis done should be regarded as preliminary; a major objective was to conceptually clarify the relevant issues.

The Meso/Industry level of analysis which followed involved both *Appreciative Theorizing* and Measurement. The former suggests that small, skill-intensive economies like Israel (I) may have a comparative advantage in post SU activity in some areas; (ii) post SU companies could contribute managerial spillovers and personnel spin-offs to SU companies—neither of which are taken into account by private investors; and (iii) SU activities face a distinctive set of risks compared to post SU companies involved in downstream production and marketing (e.g. greater sensitivity to the Nasdaq index); and that these manifest themselves especially during periods of boom in global capital markets (with private agents behaviour not necessarily aligned with 'socially desirable' patterns of investment). All of this indicates that a priori there may be excessive investments in SU relative to post SU activity. The high share of SU 'output' in total high tech output of Israel during 2000 (and 1999) suggest that this may have been the case towards the end of the decade. This conjecture is further reinforced by the crisis of high tech during the last two

years where SU output has suffered greatly and where its contribution to economy wide growth was negative.

Policies to enhance R&D leverage have not been systematically followed in Israel, although some improvements and enhanced flexibility has been registered towards the end of the decade. The microeconomic case study work and appreciative theorizing suggests four 'areas/objectives of policy': facilitate the IPO of very good SU companies (this is very important nowadays with the high tech crisis); direct support of downstream production and marketing(maybe a mixed between horizontal & targeted policies); general infrastructure support; & support of management and management spillovers of incumbent companies. Both incentives and 'institutional changes' are important in each one of these areas.

While the Israeli experience cannot be transferred directly to other high tech industries of peripheral economies or regions the framework of analysis adopted may be useful to clarify the issues and to contrast the Israeli profile of events/ policy with alternative ones that other countries/regions may want to adopt. Moreover, we are confident that specific events that occurred or actions that have been taken may have a more direct applicability in some contexts.

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