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Conference Paper

Different Paths to Success: The Growth of the Electronics Sector in Ireland and Israel

39th Congress of the European Regional Science Association: "Regional Cohesion and Competitiveness in 21st Century Europe", August 23 - 27, 1999, Dublin, Ireland

Provided in Cooperation with:

European Regional Science Association (ERSA)

Suggested Citation: Roper, Stephen; Frenkel, Amnon (1999) : Different Paths to Success: The Growth of the Electronics Sector in Ireland and Israel, 39th Congress of the European Regional Science Association: "Regional Cohesion and Competitiveness in 21st Century Europe", August 23 - 27, 1999, Dublin, Ireland, European Regional Science Association (ERSA), Louvain-la-Neuve

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<https://hdl.handle.net/10419/114376>

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EUROPEAN REGIONAL SCIENCE ASSOCIATION/ REGIONAL SCIENCE
ASSOCIATION INTERNATIONAL

39TH European Congress, Dublin

Different Paths to Success?

The Growth of the Electronics Sector in Ireland and Israel

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Acknowledgements: Work for this paper was largely completed while Stephen Roper was visiting the S Neaman Institute for Advanced Studies in Science and Technology, Technion, Haifa, Israel. Valuable comments on an earlier draft were received from Duncan McVicar (NIERC).

Abstract

Both Ireland and Israel have achieved spectacular economic growth rates in recent years due, in part, to a rapid expansion of the electronics sector. Israeli electronics has its main export-market strengths in the research intensive, leading edge markets for telecommunications and medical diagnostic equipment. The Israeli sector is also dominated by locally-owned companies with very high levels of graduate employment and high levels of R&D activity. By contrast, the Irish electronics sector is dominated by large, highly productive externally-owned plants involved in the production of products initially developed elsewhere. These plants have – by Israeli standards – very low levels of graduate employment and in-house R&D expenditure. A cruder characterisation of the positions adopted by Ireland and Israel within the global electronics sector, at least until the late-1980s, would see Ireland as a ‘production platform’ and Israel as a ‘development centre’.

Differences in the electronics sector in each country reflect the social and political situation of the two economies as well as differences in technology and industrial policy. Particularly important in terms of industrial policy has been very high level of government support for military development and civilian R&D in Israel compared to the more ‘production’ oriented assistance package available in Ireland. In 1994, for example, government supported 26 per cent of civilian R&D by businesses in Israel compared to only 10 per cent in Ireland.

In terms of its attractiveness as an inward investment or re-investment location, Ireland may still have some cost advantages for large scale manufacturing operations. High levels of public support for R&D in higher education and the availability of highly skilled labour, however, make Israel a more attractive location for research-intensive activities or niche manufacturing. Israel continues, however, to export much of the knowledge generated in its research and development centres. Following Ireland, encouraging inward investment in large-scale production facilities may be one route that Israel could follow to retain more of the value added generated by the products it develops. For Ireland the key challenge is to attract more research-intensive activities. Israel’s experience suggests this will require increased public support for R&D; the development of substantial measures to promote high-tech entrepreneurship, and the establishment of international R&D partnership agreements similar to the Israeli-US BIRD fund.

Different Paths to Success?

The Growth of the Electronics Sector in Ireland and Israel

1. Introduction

Over the last decade the Israeli and Irish economies have maintained what are, by western standards, phenomenally high national growth rates. In Israel from 1990-96, real national GDP grew by 5.8 per cent pa, compared to a GNP growth rate of 5.2 per cent pa in Ireland¹. Over the same period annual GDP growth averaged just 1.4 per cent in the EU15 and 1.8 per cent in the OECD. A major element in the growth of both the Irish and Israeli economies has been the rapid expansion of high-tech industry, dominated by electronics but also including optical and precision equipment and pharmaceuticals². In Ireland, this growth has been due largely to a consistent flow of inward investment (and more recently re-investment) by electronics companies, primarily from the US³. O'Riain (1997), for example, highlights investments by Dell, Gateway and AST Research in the personal computer sector and HP, Keytronic, Seagate, 3Com and Motorola making peripherals and networking products. In addition, Intel have two wafer fabrication plants near Dublin which currently employ around 2,700 people. Figures published by the Industrial Development Authority (IDA) suggest that by mid-1998 there were over 200 externally-owned electronics companies in Ireland employing over 33,000 people. More significant perhaps is that 61 per cent of electronics plants in Ireland are US-owned, and that these plants currently account for 82 per cent of employment in the electronics sector.

Israel too has seen some notable examples of inward investment by US and other electronics companies although, prior to 1994 and the start of the Middle East Peace Process, these investments tended to be either R&D or product design centres or

¹ GNP figures are used for Ireland because in recent years repatriated profits have been a significant proportion of GDP. Sources: Israel, Bank of Israel Annual Report, 1996, Table 2.A.1; Ireland, Central Statistics Office, Dublin, Principal Statistics; OECD and EU15, OECD, Paris.

² On the importance of high-tech industry in Ireland see the references in Gorg and Ruane (1998). On Israel, see, for example, Teubal (1993).

relatively small scale production facilities. Intel, for example, established its first R&D facility outside the US in Israel in 1974, followed more recently by National Semiconductor, Motorola, IBM, Digital, Apple and Microsoft (Frucht-Eren, 1996). Since 1994, major investments by Intel and Motorola have been accompanied by a number of significant joint ventures. Northern Telecom, for example, recently took a 20 per cent stake in Telrad Telecommunications and Electronics. Despite these recent investments the level of external ownership in the Israeli electronics sector remains relatively low. Indeed, the profile of the electronics industry published by the Israeli Association of Electronics Industries (1998) suggests that only around 16 per cent of all electronics plants in Israel are externally-owned and that these plants provide around 10,000 jobs or a quarter of all electronics employment. As in Ireland, US companies dominate the externally-owned sector accounting for around nine-tenths of jobs, of which around half are provided by Intel and Motorola.

The relatively small scale of the externally-owned segment of the electronics sector in Israel means that output and export growth have resulted primarily from the expansion of indigenously-owned companies. The contrast between this pattern of indigenously-driven development and the externally-driven growth of the electronics industry in Ireland suggests two questions. First, what differences in factor endowments, institutional frameworks, tax policy or investment incentives have been important in stimulating the much stronger development of the indigenous electronics industry in Israel? Second, what implications do the resulting differences in ownership, location and product focus have for the sectors' future prospects? This latter point may be particularly important in the electronics sector, where product life-cycles are short and external-ownership has been shown to have an inhibiting effect on plants' innovation intensity (e.g. Love and Roper, 1997)

The remainder of the paper is organised as follows. Section 2 profiles the growth of the electronics sector in Israel and Ireland since the late 1980s, highlighting the sectors' increasing shares of national exports and world markets. Evidence from

³ The earliest major investment was by Digital who began making minicomputers in Galway in 1971. This was followed, among others, by Analog Devices in 1977 (Limerick), Amdahl in 1978 (Dublin) and Apple in 1981 (Cork) (O'Riain, 1997).

company surveys is then used to provide a more in-depth picture of the market position adopted by the electronics sector in the two areas. Clear differences emerge between the Israeli and Irish electronics sectors both in terms of the type of products they produce and the position of the two sectors in the electronics value-chain. Subsequent sections explore the background to these very different development paths. Section 3, for example, focuses on the role of the electronics sector in the development strategy of each country while section 4 outlines the types of public support available for capital investment and R&D. Section 5 focuses on the availability, quality, cost and productivity of skilled labour in the two economies. Section 6 draws together the main points of the discussion and, assuming a continuation of the Middle East peace process, draws some general conclusions about the prospects for future success of the electronics industry in Ireland and Israel.

2. Electronics Growth in Israel and Ireland

Much of the impressive national growth achieved by Israel and Ireland over the last decade is attributable to a rapid expansion of the two economies' manufacturing sectors. In Israel, for example, the volume of manufacturing sales grew by an average of 8.1 per cent pa from 1989-95 compared to 8.9 per cent in Ireland. Manufacturing exports also grew rapidly in both countries, accounting for 26-28 per cent of all manufacturing sales in Israel but 61-65 per cent in Ireland (Table 1). Sales and exports in the high-tech sector grew at a similarly rapid pace. From 1989-95, electronics production in Ireland grew by an annual average of 8.2 per cent compared to 8.9 per cent in Israel. EU electronics production over the slightly shorter 1990-94 period averaged a less impressive growth of 3.6 per cent pa⁴. Export growth in both the Israeli and Irish electronics sectors was broadly in line with sales volume growth during the early-1990s, with exports accounting for 46 per cent of all sales by Israeli firms but 91-96 per cent of sales by Irish electronics businesses (Table 1). These relatively high exports shares, together with above average sales volume per employee, mean that in both Israel and Ireland the high-tech sectors account for a disproportionately high proportion of manufacturing sales and exports. In 1995, for

⁴ Source: Table 3, section 14.2, Panorama of EU Industry 1997, EU Commission.

example, the electronics sector in Israel accounted for 15.2 per cent of all manufacturing jobs but 28.8 per cent of manufacturing exports. In Ireland in 1995, the same proportions were 20.7 per cent and 35.5 per cent respectively.

Aside from their impressive growth performances it is arguable whether the Israeli and Irish electronics sectors have much else in common. Sales per employee in the Irish industry is more than twice that in Israel, and the Irish sector also exports a very much higher proportion of its production (Table 1). Important differences also exist in the specific market segments in which the Irish and Israeli industries are concentrated. Table 2, for example, gives data for the exports from Ireland and Israel in 1996 of the main civilian electronic products and identifies those markets in which the two countries had above average export market shares⁵. Israeli exports of this group of products totalled \$3.9b, and were dominated by telecommunications equipment in which Israel had a 1.5 per cent share of world exports. Israel had a larger – 1.7 per cent – share of the relatively small world market for medical diagnostic equipment. Both markets are leading edge sectors where competition is knowledge rather than cost-based (Maital et al., 1994; Frenkel et al., 1994). By contrast, electronics exports from Ireland are dominated both in terms of value and world market share by the volume production of computer and office equipment and components. In 1996, these product groups accounted for two-thirds of Irish electronics exports and represented almost a twentieth of all world exports (Table 2).

More insight into the contrasts between the Israeli and Irish electronics industries can be obtained from company survey data on plants' innovation and technological development activity. Shefer and Frenkel (1998), for example, report survey results derived from detailed interviews with a representative sample of electronics companies in Northern Israel in 1995. Comparable information for Irish electronics businesses is taken from a structured postal survey undertaken in 1996-97 (Roper and Hewitt-Dundas, 1998). Data from both surveys is reported in Table 3 with separate figures being given for indigenously and externally-owned businesses. In terms of the basic

⁵ Because of differences between the industrial and trade classifications this group of electronics products do not match the growth and performance data given in Table 1. In 1996, these products

characteristics of the businesses surveyed, Table 3 confirms a number of observations made earlier. For example, the survey data reflects the dominance of locally-owned plants in the Israeli electronics sector and that of externally-owned plants in the Irish industry. Notable differences exist, however, between the average size of locally and externally-owned plants in both Ireland and Israel. This difference is most marked for the group of externally-owned plants in Ireland which are, on average, the largest plants and have sales per employee twice that of any other group of firms. In terms of their technological development activity there are also marked differences between the Israeli and Irish plants. For example, the average percentage of graduate employees in Israel is 3-5 times higher than that in Ireland accompanied by much higher levels of R&D expenditure measured both in absolute terms and relative to sales (Table 3). Moreover, over half of the externally-owned plants in Ireland indicated that they were not undertaking any R&D in 1995 with around a quarter also indicating that they had introduced no new or improved products during the last three years.

3. Policy and Trends in Inward Investment

One possible explanation for the very different development paths of the electronics sectors in Israel and Ireland is the different scientific and policy traditions of the two countries. Strong contrasts exist, for example, between the tradition of applied scientific research in Israel and the more 'academic' tradition of science in Ireland. In Israel, evidence of the practical application of scientific research dates back to before the establishment of the state with the foundation of the Hebrew University, the Technion and the Weizmann Institute (Teubal, 1993). After the establishment of Israel in 1949, institutional and policy developments continued this tradition maintaining a close relationship between scientific research and industrial and military development. In Ireland, by contrast, scientific excellence was traditionally:

'... cultivated for an international audience. The work of the foremost scientists showed few signs of being significantly Irish. It dealt in abstract, would-be universal propositions ... In other words science prior to partition was primarily practised as a form of high culture' (Yearly, 1995, p. 173).

accounted for 32.6 per cent of all exports from Ireland and 19.4 per cent of all Israeli exports. For sources see the notes to Table 2.

Following partition in 1921 and the creation of the Irish state this tradition continued with the consequence that scientific research and policy continued largely independent of industrial development until the mid-1980s (Yearly, 1995).

During the early part of the intervening period, governments in both Israel and Ireland adopted a protectionist stance aimed primarily at the development of indigenous industry (Wrynn, 1997; Teubal, 1993). Ireland was the first of the two countries to adopt a more open trade policy, easing import restrictions as part of the acceptance of Marshall Aid after 1948 (Wrynn, 1997). The Irish policy of indigenous development during the 1950s was, however, conspicuously unsuccessful and, by the end of the decade, an increasingly uncompetitive industrial base was evident in faltering economic growth, high unemployment and a severe balance of payments crisis. A re-evaluation of policy followed, leading to the dismantling of import quotas and, from 1958 onwards, to a policy of encouraging export-oriented investment by both foreign and locally-owned manufacturing firms. For potential inward investors the incentive package included a combination of automatic and discretionary elements: an automatic tax holiday on new export sales for an initial period of ten years was augmented by discretionary cash grants for capital equipment and training (Ruane and Gorg, 1997)⁶.

The trend towards the increasing openness of the Irish economy which started with the policy changes of 1958, continued with the signing of the Anglo-Irish Free Trade Agreement in 1965 and Ireland's joining of the General Agreement on Trade and Tariffs (GATT) in 1967 (McAleese, 1971)⁷. Over the same period, Israel continued its strong protectionist stance as it developed its physical, industrial and institutional infrastructure (Plessner, 1994). Israeli government – dominated for most of this period by the interventionist Labour party – adopted a strong strategic role in both the military and economic spheres⁸. In military terms, expansion during the 1960s was

⁶ Ruane and Gorg (1997) also stress the importance of certainty in the attractiveness of these incentive packages, particularly in terms of the guaranteed length of the tax holiday.

⁷ Note that Ruane and Gorg (1997) suggest that the scale of FDI to Ireland was particularly important during this period in allowing Ireland to maintain exchange rate parity with the UK and compensate for job losses in the indigenous sector in the face of increasing exposure to external competition.

⁸ See Pessner (1994) for an assessment of the impact on the Israeli economy of continued government intervention and particularly the continued public sector dominance of the capital market.

based largely on the licensed production of some weapon systems based on partnerships between foreign firms and Israeli public sector organisations. Israel Aircraft Industries (IAI), for example, began producing Fouga Magister jet trainers under French license and the defence electronics sector was established through Tadiran and Elbit (Steinberg, 1985, pp 390-391). Following the Six-day war of 1967 the French embargo on defence sales to Israel stopped any collaborative defence projects and stimulated a massive growth in the Israeli defence industry. IAI, for example, grew from 4,000 employees in 1967 to 14,000 by 1971 and 20,000 in 1977 producing first the Nesher (an Israeli version of the Mirage III) and later the more advanced Kfir combat plane (Steinberg, 1985). Other types of military hardware were also developed locally including tanks (notably the Merkava), missiles, artillery and defence electronics systems. The growth of the Israeli military complex did not take place in isolation, however, with both production and managerial techniques and military technologies quickly transferred to the civil sector. Steinberg (1985) highlights in particular the expansion of IAI into civilian aircraft production, the move by Tadiran and Elbit into civilian markets and the rapid growth of sub-contracting in the defence industries in the 1970s.

Alongside its lead role in the development of the military complex, the Israeli government also adopted a strong strategic role in the development of the nation's civilian industrial, scientific and technological infrastructure. Towards the end of the 1960s in particular, development policy shifted away from the promotion of basic industries towards more export-oriented, capital intensive and eventually high-tech sectors. The main form of assistance for Israeli private sector companies over this period was capital grants which were introduced initially in the 1959 Law for the Encouragement of Investment (Lavy, 1994). As early as the 1960s, the Israeli government – through the Ministry of Industry and Trade - also supported the development of Science Parks at the universities (e.g. the Kiryat Weizmann Science Park in 1967; Felstenstein, 1994). Also during the 1960s, the Israeli government began to give R&D grants to individual firms, a development that Teubal (1993) suggests might be the first instance of this type of policy intervention.

In Ireland, industrial policy during the 1960s was marked by a reliance on FDI with most investment coming in labour-intensive, technologically mature sectors such as textiles, plastics and light engineering (Wrynn, 1997). In the early 1970s, new inward investment to Ireland averaged 1.5-2.0 per cent of GDP each year and the emphasis shifted increasingly towards electronics and chemicals (Figure 1). This, as the Telesis Report of 1982 recognised, contributed to the emergence of a dual economy in Irish manufacturing: a technologically advanced, externally-owned sector based on R&D conducted elsewhere and a technologically weaker locally-owned sector (NESC, 1982). Neither the externally-owned or indigenous sector depended on, or benefited substantially from, R&D conducted in Ireland (OECD, 1974).

In Israel, the 1970s were marked by a continuation of large-scale, albeit declining, defence spending (Figure 2), alongside increasing openness to trade and foreign investment. A Free Trade Agreement was negotiated with the EU in 1975 and bi-national R&D funds were established with the US (i.e. BIRD) and Germany (i.e. Israel- German Foundation or GIF). Attempts were also made during this period to attract more inward investment, particularly to more peripheral areas (Shefer and Bar-El, 1993)⁹. Despite relatively high capital grant rates, however, these efforts met with only limited success with new FDI remaining at around 0.3 per cent of GDP throughout the latter half of the 1970s (Figure 1)¹⁰. Alongside this limited FDI, rapid structural change was taking place in the indigenously-owned sector as the military build-up continued and the related civil electronics and aircraft industries expanded. From 1968-83, for example, high-tech industry in Israel increased its share of output from 6 to 24 per cent and its share of exports from 5 to 28 per cent (Teubal, 1993).

The rapid development of the Israeli electronics industry was threatened during the early to mid-1980s by adverse macro-economic conditions. This was evident in declining total factor productivity growth (TFPG) rates both in manufacturing

⁹ Steinberg (1985) indicates that the decentralisation of the Israeli defence industry during the 1970s was also used as a tool for the industrial development of the Israeli periphery. Although the quantitative impact of this remains uncertain, important defence manufacturing sites were established at Karmiel in the Galilee, Be'er Shiva and in other parts of the Negev.

¹⁰ One notable success, however, was the establishment by Intel in 1974 of a major research and development facility in Haifa. This recently expanded development was and remains Intel's only R&D facility outside the US in Haifa in 1974 (Frucht-Eren, 1996).

(Bregman, 1987) and in the economy as a whole during the early 1980s (Syrquin, 1986). Teubal (1993) highlights three contributory factors: the direct effects of rapid inflation which reached 400 per cent pa in 1983-84, a failure to index interest payments on government loans which led to the adoption of highly capital intensive production techniques (Metzer, 1986), and the crowding out of civilian electronics development by the defence sector. Post-1984, macro-economic stability was restored and FDI to Israel rose to average 0.6 per cent of GDP from 1985-90 (Figure 1). Throughout this period the main instruments of industrial support in Israel continued to be automatic, fixed rate capital and R&D grants. Capital grant rates have declined through time from a high of 40 per cent during the 1960s to 20-25 per cent in more recent years. R&D grants, the structure of which was formalised in the 1984 Law on the Encouragement of Industrial R&D, are also automatic with the basic rate of 50 per cent of project cost remaining the same since the 1960s.

Growth in the Israeli defence sector continued during the mid-1980s with perhaps the most important single project being the development of the Lavi fighter. This was a development of the American F-16 with enhanced electronic systems developed by Israeli companies. The first prototype aircraft were flown in 1986-87 but the project was cancelled in 1987 in the face of increasing costs and US pressure. Other external factors, including the end of the Cold War and the easing of the geo-political situation in the Middle East also reduced both export and domestic demand for military hardware. Domestic defence spending declined particularly sharply from 21.1 per cent of GNP in 1985 to 13.8 per cent by 1990 and 10.1 per cent by 1996 (Figure 2)¹¹. These reductions in the demand for military equipment and the cancellation of the Lavi project inevitably released substantial amounts of highly skilled labour into the Israeli labour market and there is some anecdotal evidence that this has stimulated high-tech entrepreneurship in Israel. Recent examples of this type of development are ECI Telecom, a producer of telecommunications systems for PTTs, which was founded by people who had previously served in the IDF communications units. Former IDF

¹¹ Source Bank of Israel, 1996, Table 5.A.6. Note also that these reductions in domestic military spending underestimate the real reduction in spending on military hardware due to the increase in labour costs as a proportion of total defence spending. In 1985, labour costs accounted for 39.6 per cent of all defence spending compared to 58.4 per cent in 1996.

intelligence staff also founded NICE Systems, producers of digital recording systems¹². More formal statistical and econometric studies, however, provide little evidence that defence spin-offs have been significant at an economy-wide level. De Rouen (1995), for example, analyses the impact of military spending on GDP growth in Israel for the period up to 1988 and finds only weak evidence of positive spin-off effects. Similarly, Cohen et al., (1996) are able to identify no significant spin-off effect from Israeli defence spending on levels of labour productivity. Despite these results, and the fact that since 1994 there has been a marked increase in FDI into Israel (Figure 1), the electronics industry in Israel continues to be dominated by firms with their HQ's located in the country. Indeed, Motorola and Intel are the only externally based manufacturers in the top twenty companies in the Israeli electronics sector (Table 4). The largest companies – Tadiran and IAI Ltd – reflect the strong historical links between the military and civilian electronics industries in Israel.

In Ireland, as in Israel, the early-1980s were uncomfortable times, as the after-effects of the oil price shocks were exacerbated by interest payments on foreign borrowing and profit repatriation. Indeed, from 1979-86, as the level of new FDI declined sharply (Figure 1), the Irish economy ceased to grow and disposable income per capita actually declined as population grew rapidly (Yearly, 1995). The decline in FDI over this period, and the poor macro-economic situation, also exposed the weakness of much of Ireland's indigenous industrial base. This reinforced the case made by NBST (1983) and others of the importance of maximising the potential contribution of science and technology to the development of the competitiveness of locally-owned firms. Unfortunately, however, as the economic crisis continued, pressure on the Irish exchequer led to cuts in the science budget in the face of more immediate social problems (Yearly, 1995). External influences in the shape of the European Commission also forced changes in 1982 in the package of investment incentives offered by the Irish government. While maintaining the combination of automatic and discretionary incentives, the Irish government was forced to restructure the support package to remove any bias towards the support of export sales. Previous measures were replaced with an automatic 10 per cent profits tax for all new firms, regardless of whether they

¹² Source: Financial Times, July 15 1996, Survey of Israel – 'Swords into Ploughshares'.

were exporting, and the availability of discretionary grant support was also extended to all manufacturing companies (Ruane and Gorg, 1997). More recently, the continuing need to promote technological development in indigenous Irish industry has been emphasised by the Industrial Policy Review Group (Culliton, 1992). This reorientation of technology policy has been strongly promoted and financially supported by the EU both through the Structural Funds and the Framework programmes (see for example, STIAC, 1995, vol. 3, pp. A42-43)¹³.

In more recent years while the scale of new FDI into Ireland has declined as a share of GDP, reinvestment and plant expansions have become much more important (Figure 1). Figures provided by the Central Statistical Office for the 1991-96 period suggest total reinvested earnings in excess of £5.2bn, more than four times the net flow of new inward investment over the same period. The cumulative effects of Ireland's FDI flows are also evident in terms of the relatively large share of economic activity accounted for by multi-national enterprises (MNEs). Ruane and Gorg (1997) quote figures which suggest that inward investors account for 44.1 per cent of manufacturing employment, 68.4 per cent of net output (i.e. value added) and 87.7 per cent of exports. The same cumulative effect is also evident in terms of the top 20 companies in the Irish electronics sector. Only two Irish firms appear on the list (Table 5). Of the remaining firms, 12 have headquarters based in the US and five are headquartered in other European countries and one is Japanese.

The importance of the externally-owned sector in Ireland is increased by the continued decline in manufacturing employment in indigenously-owned companies. O'Sullivan (1995), for example, reports figures suggesting that from 1973-94 while manufacturing employment in non-Irish companies rose by 29 per cent that in Irish firms fell by 21.3 per cent. Ruane and Gorg (1997) also point out, however, that the distribution of inward investment projects to more rural areas in Ireland has been important in counteracting high rural unemployment. More uncertainty surrounds the importance of Irish FDI in terms of its backwards linkages, with studies suggesting that foreign-

¹³ The importance of EU funding in these measures, however, raises important questions about their relevance to the specific needs of Irish industry and the external dependence of Irish technology policy (Yearley, 1995).

owned companies operating in Ireland have weaker backwards linkages than similar Irish-owned firms (McAleese and McDonald, 1978; O'Farrell and O'Loughlin, 1980 and 1981). More recently, Gorg and Ruane (1998) also found that in 1995 Irish-owned electronics companies were purchasing 32 per cent of their inputs in Ireland compared to 23 per cent in externally-owned businesses. As Gorg and Ruane (1998) acknowledge, however, relatively little is known about the nature of the firms from which these 'local' supplies are being sourced, the employment effect of such sourcing or any technology transfer type benefits.

4. Current Support Regimes

The high R&D and capital intensity of the electronics sector emphasises the potential importance for FDI of investment and R&D incentives. In terms of capital grants, the system in Israel is the most transparent as grant rates are fixed depending on investment location and project size (Ministry of Industry and Trade, 1997). In 1997, for example, grant rates on approved investment expenditure were: 0 per cent in the central region; 10 or 12 per cent in intermediate regions and 20 or 24 per cent in the most peripheral areas. Since 1st January 1997, firms locating in the most peripheral areas also get 2 years of profit tax remission and five years of reduced tax liability. Fiscal incentives are also provided in Israel with inward investment projects which are more than 90 per cent externally-owned facing a 10 per cent corporation tax rate, with the rate increasing as local ownership increases¹⁴. In Ireland, the current package of investment incentives comprises both automatic (i.e. fiscal) and discretionary grant based elements with the latter again depending on the attractiveness, location and employment potential of individual projects (Ruane and Gorg, 1997)¹⁵. In addition to a 10 per cent profits tax guaranteed to 2010, the most recent figures suggest that in 1992

¹⁴ Corporation tax rates in Israel depend on ownership and the firm's status in terms of the 1979 Capital Investment Act. Non-approved firms face the standard corporation tax rate of 36 per cent, while approved firms which are locally owned face a tax rate of 25 per cent. Approved firms with an external-ownership share of 49-74 per cent pay 20 per cent and those with an external-ownership share of 74-90 per cent pay 15 per cent (Ministry of Industry and Trade, 1997)

¹⁵ Maximum grant rates do exist but are very rarely offered. The IDA's New Industry Programme offers capital grant rates up to 60 per cent in the development areas and up to 45 per cent elsewhere (Yuill et al., 1997).

average capital grant offers through the IDA's New Industry Programme averaged 22.7 per cent of total project investment (Yuill et al, 1997)¹⁶.

In addition to these capital incentives, substantial support is available for R&D. This is important as the survey evidence included in Table 3 suggested that R&D expenditure was equivalent to 28-43 per cent of the sales of Israeli electronics firms but only 0.9-1.3 per cent of that of Irish companies. Up-front support for R&D is most generous in Israel where fixed-rate grants of 50 per cent of all approved R&D expenditure are available for the development of innovative new products¹⁷. Grant support is repayable, however, if the project proves commercially successful. In Ireland, support for R&D and other aspects of technological development is provided by Enterprise Ireland on a discretionary basis, with a maximum grant rate of 50 per cent of the eligible *non-capital* element of project cost. Differences in the extent of public support for business R&D are most evident, however, from aggregate figures which suggest that in 1994, the Israeli government funded 26.1 per cent of all civil R&D by businesses compared to 10.0 per cent in Ireland (Table 6). This differential is also evident in higher levels of government (civilian) R&D in Israel and, in particular, in much higher levels of R&D in Israeli higher education (Table 6).

As well as these investment and R&D incentives for existing businesses and inward investors support is also available in both Israel and Ireland to encourage high-tech business start-ups. In Israel, the 1984 Law for the Encouragement of Industrial R&D makes specific provision for the support for R&D start-ups by providing a (repayable) grant of 66 per cent of project costs up to a maximum of \$250,000 over 2 years. Support for high-tech start-ups was further increased in 1991, however, with the establishment of the Technological Incubators Programme (OCS, 1997a) which

¹⁶ The relative importance of the fiscal and discretionary elements of current incentive packages has attracted considerable debate. Ruane and Gorg (1997) summarise the debate by stressing the importance of Double Tax agreements and noting that: '*Comparing tax incentives with other incentives, various surveys have concluded that the tax incentives are the most important incentive encouraging manufacturing investors to locate in Ireland. For example, a recent Deloitte Touche Tohmatsu survey indicated that almost 60 per cent of foreign companies interviewed found the ten per cent rate to have been very influential in their location choice. Furthermore, IDA Ireland personnel would suggest that tax incentives are particularly popular with US firms*'.

¹⁷ R&D projects conducted in more peripheral areas attract an even higher grant rate of 60 per cent of approved costs (Source: OCS, 1997).

provides grant support of up to 85 per cent of project cost (to a maximum of \$300,000 over two years). The 1996 budget for this programme alone was \$32m, or around 7 per cent of the budget of the CSO of the Ministry of Industry and Trade for the promotion of industrial R&D (Shefer and Modena, 1998; Roper, 1998). In Ireland, little specific public assistance is available for high-tech start-ups although such firms, like those in other sectors, are eligible for relatively modest employment and R&D grants. Employment grants provide a fixed level of support for each job created with the average grant rate probably being lower than that provided by the New Industry Programme. R&D grants are available to high-tech start-ups on the same basis as they are to other firms (i.e. to a maximum of 50 per cent of the non-capital element of R&D costs).

Support is also available in both Ireland and Israel for collaborative projects in specific areas of technological development. In Ireland, local co-operation is promoted both through the National Linkages Programme and through the Projects in Advanced Technology, which are funded research collaborations between companies and higher education institutions. Similar collaboration between higher education institutions and companies in key technological areas is also funded in Israel through the MAGNET programme (OCS, 1997). International collaboration by Irish firms is primarily through Irish participation in EU programmes such as EUREKA and the Framework Programmes in which Israel also participates. Israel also has a number of other bi-national R&D support schemes with the US (BIRD), Canada, Singapore, Korea, France and Germany and most recently the UK (BRITECH)¹⁸.

5. Labour Availability, Cost and Productivity

Another key aspect of the operating environment of high-tech industry is the availability and cost of skilled manpower, although as Table 3 indicated firms in Israel have much higher levels of graduate employment than those in Ireland. Two factors are

¹⁸ The BRITECH agreement was signed on 24th May 1999 with an initial fund of £15m. At the launch of the agreement Stephen Byers, Secretary of State for Industry and Trade announced 'This is the *first* joint research and development fund to be established between the UK and another country. It is an important and exciting step which will help industrial partners pull their ideas through to the market place' (DTI Press Release, p/99/427, 23 May 1999).

important here: the overall level of education of the population and more specifically the size and competence of nation's cohort of scientists, technologists and engineers. Aside from the education system, however, and in the cases of Israel and Ireland in particular, it is important to consider the effect of migration on the pool of skilled labour: Israel has benefited substantially in recent years from the inflow of highly skilled immigrants from the former Soviet Union, while Ireland has experienced almost consistent net out-migration every year for the last 30 years.

Overall, current levels of investment in education as a percentage of GDP are very similar in Israel and Ireland (Table 7). UNESCO figures also suggest that levels of enrolment in 3rd level education and student numbers relative to the population as a whole are also broadly similar having risen rapidly in recent years¹⁹. In terms of the subject coverage of 1st degrees, a larger proportion of Israeli graduates have engineering and medical, health related degrees with fewer gaining qualifications in natural science, mathematics or computer science than in Ireland. The proportions of those with first degrees that go on to do higher or research degrees is now also broadly similar. In 1994/95, for example, 45.9 and 41.1 per cent of science graduates in Israel and Ireland stayed on to do a higher degree (Table 7). UNESCO figures suggest that these proportions have changed considerably in recent years. In Ireland, for example, staying on rates have risen sharply since 1992 when only 17.9 per cent of science graduates took higher degrees. In 1992 this meant that the flow of people with research training leaving the Israeli universities was nearly three times that in Ireland. The rise in the staying-on rate in Ireland since 1992 has almost eliminated this differential.

In addition to this flow from the education system Israel has also benefited in recent years from substantial flows of in-migration or Aliya. Simmonds (1993), for example, notes that from 1989-92, there were some 450,000 immigrants to Israel from the former Soviet Union (equivalent to 10 percent of the 1989 Israeli population) of whom 40 per cent were university graduates compared to 10 per cent of the established workforce. Frucht-Eren (1996) adds:

‘Of the 750,000 immigrants who arrived between 1989 and 1995, there were nearly 11,000 scientists and research engineers – 1.5 per cent of the population. This influx swelled the ranks of Israel’s scientific and engineering community from 15,000 to 26,000 in just six years. Another 1,000 scientists and engineers (out of 80,000 immigrants) were expected to arrive in 1996. Although not all have found work in their own fields, on the whole they have had a profound effect on Israeli academia and industry. Many have had to be retrained to meet Israeli standards in various fields. But others have brought with them rare expertise’ (p. 9)²⁰.

Even prior to the wave of immigration from the former Soviet Union, however, Israel had proportionately more scientists and engineers engaged in R&D than Ireland²¹. In part this was due to the build-up during the 1970s of the Israeli defence sector (Teubal, 1993) but it also reflects the consistently higher proportion of national GDP devoted to R&D in Israel (Table 6). The high proportion of Israeli science graduates who undertake higher degrees, and immigration from the former Soviet Union, means that Israel now has a higher proportion of engineers and scientists in the labour force than any other country in the world - 133 for every 10,000 citizens (Frucht-Eren, 1996).

The availability of a pool of such high quality labour is an obvious attraction for research intensive activities such as electronics. Low labour productivity or high labour cost may, however, offset these advantages. In terms of labour cost information is available from both Census of Production and the US Bureau of Labour. Census data, which is specific to the electronic machinery and professional, scientific and measurement equipment sectors, suggests that in 1994 average labour costs in electronics plants in Ireland were 65-70 per cent of those in Israel. This comparison, however, is misleading as it reflects both labour cost differentials and the very different

¹⁹ In 1991/92 enrolment in 3rd level education in Ireland was 34.2 per cent of 18-22 year olds, compared to 35.3 per cent in Israel (Source: UNESCO Statistical Yearbook, 1995).

²⁰ However, see Czamanski et al, 1994 for a discussion of the absorption difficulties of Russian immigrants in the Haifa area.

²¹ The most recently published data for Israel relates to 1984. At this time there were 4826 scientists and engineers engaged in R&D per million inhabitants compared to 1871 per million in Ireland in 1993 (Source: UNESCO Statistics Yearbooks, 1995 and 1997).

skill composition of the whole workforce of Israeli and Irish companies (see, for example, Table 3). Indeed, hourly compensation costs for *production workers* in all manufacturing sectors published by the US Department of Labour suggest that in 1994 labour costs in Ireland (\$12.4 per hour) were 35 per cent above those in Israel (\$9.2 per hour)²².

Labour productivity figures are also available from Censuses of Production, and Table 8 gives figures for the electronic machinery and professional, scientific and measurement equipment sectors²³. Again it is important to remember that these figures reflect the very different skill composition and market orientation of electronics businesses in Israel and Ireland. Nonetheless it is notable that in electrical machinery, output per employee in Ireland at \$282,000 pa was 2.4 times that of in Israel with value added per employee 87 per cent higher. In the manufacture of professional, scientific and measurement equipment output per employee in Ireland was 35 per cent above the Israeli level with an 84 per cent differential in value added per employee (Table 8). These differences are consistent with the survey evidence cited earlier (i.e. Table 3), which suggested that Irish electronics plants tend to be larger than their Israeli counterparts, to have more investment and capital per employee and, despite lower average skill levels, higher labour productivity. Crucially, however, they also have a much lower value added share of output than their Israeli counterparts (32 per cent compared to 42 per cent in Israel). Differentials in the manufacture of professional, scientific and measurement equipment are similar with the notable exception that value added as a percentage of sales in Ireland at 62.8 per cent is actually higher than that in Israel (46.2 per cent).

6 Discussion

Both Israel and Ireland have achieved notable success in establishing an internationally competitive manufacturing base for very specific groups of high-tech products. The nature of the electronics sectors in each country differs significantly, however,

²² Source: U.S. Department of Labour, Bureau of Labour Statistics, September 1998.

reflecting the social and political situation of the two economies as well as differences in technology and industrial policy. A crude characterisation of the positions adopted by Ireland and Israel within the global high-tech sector at least until the late-1980s would see Ireland as a 'production platform' and Israel as a 'development centre'. In more recent years, and for very different reasons, both economies have moved to a more mixed position. In Ireland, after criticism of the weak linkages of much inward investment, there have been substantial attempts to develop the technological capability of indigenous industry. For Israel, one of the spin-offs from the Middle East peace process has been the willingness of electronics multi-nationals to invest in major production facilities. In terms of capital and fiscal incentives there is now relatively little to choose between the two countries. Both are now offering investment incentives averaging 20-25 per cent of initial capital cost together with a 10 per cent corporation tax rate for externally-owned manufacturing enterprises. US Bureau of Labour Statistics suggest that hourly labour costs for production workers are lower in Israel accompanied by more generous government incentives in support of business R&D. Because of the structure of the education system and continued immigration, Israel also has a substantial advantage in terms of the availability of research-trained engineers and scientific staff.

Ireland still offers substantially lower labour costs than other EU areas and therefore maintains some cost advantages as an inward investment or re-investment location for large scale manufacturing operations serving European markets²⁴. Public support for R&D and labour availability, however, seem likely to continue to make Israel a more attractive location for more research intensive activities or niche manufacturing operations. In terms of the development of indigenous high-tech industry, Israel is also making substantially greater public investments both in terms of the support offered to R&D in existing businesses and in terms of measures to promote high-tech entrepreneurship. Substantial support is also available to Israeli companies from the bi-

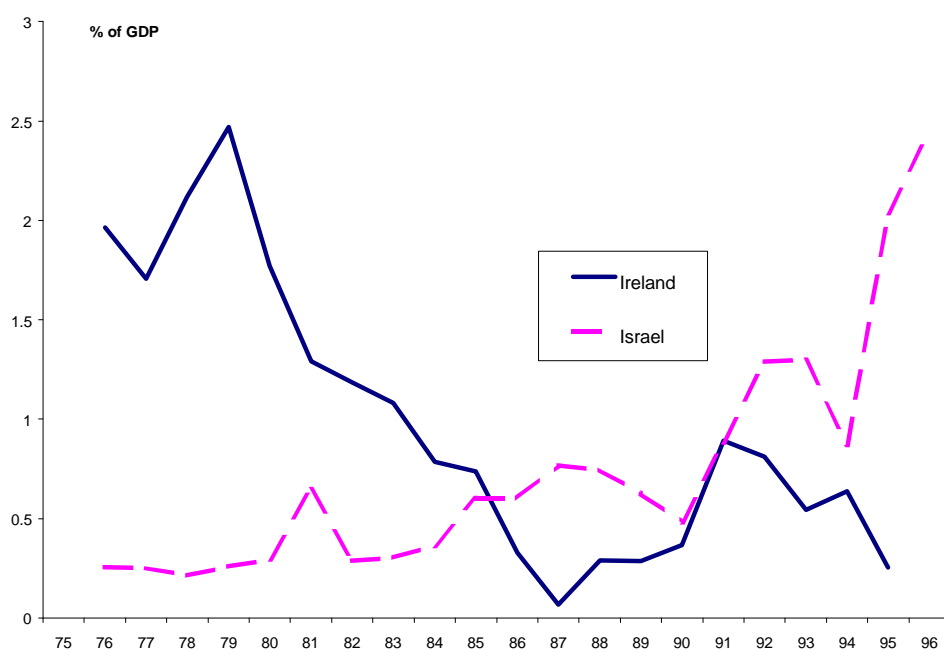
²³ In each country the manufacture of electronic machinery was much the larger of the two sectors employing 52,000 people in Israel and 27,500 in Ireland compared to 3,900 and 8,400 engaged in the more specialist manufacture of professional, scientific and measurement equipment.

²⁴ In 1997, hourly labour compensation for production workers in Ireland was \$13.6 compared to an EU average of \$20.24 (Source: U.S. Department of Labour, Bureau of Labour Statistics, September 1998).

national and international collaborative agreements in which Israel is a partner. Despite these incentives, and some exciting developments in Israeli venture capital markets, the evidence suggests that Israel still fails to retain much of the potential value added from the products of its labs and development centres. As domestically financed developments are unlikely to take up this slack, Israel, like Ireland, therefore seems likely to benefit substantially if it can continue to attract suitable inward investment to expand its production capacity. Israel's success in attracting new FDI since 1994 suggests the feasibility of such an approach.

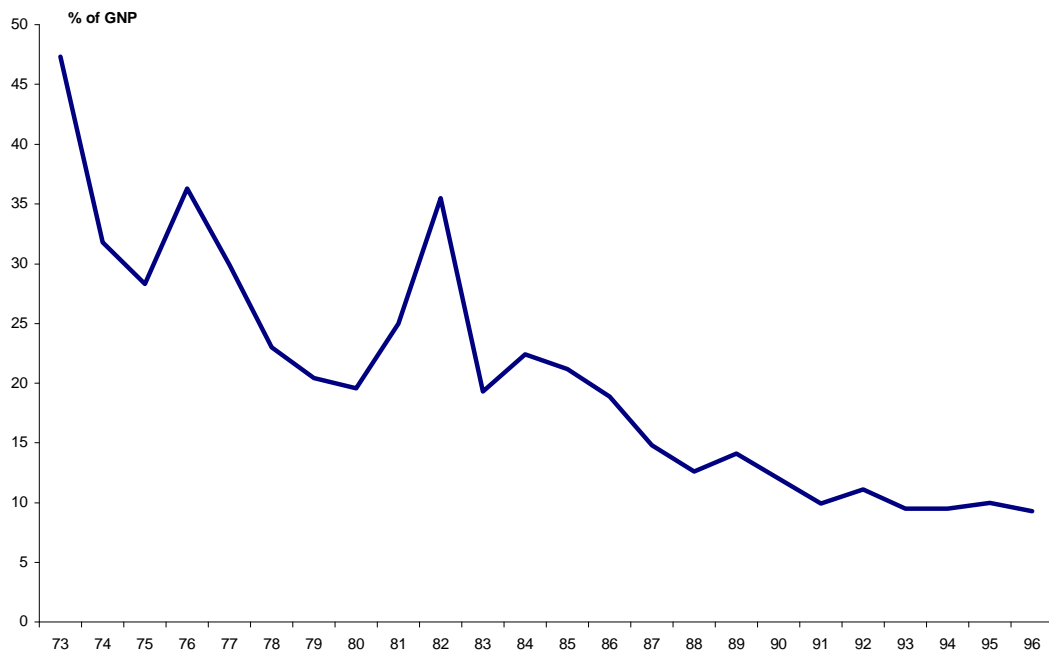
Ireland faces very different strategic problems if, in the longer-term, it is to progress beyond the status of European 'production platform'. First, there is an immediate need to increase public investment in R&D both to support applied R&D by businesses but also to increase the amount of basic science research being done in Irish universities. To reach Israeli levels the Irish government would need to increase its level of support for business R&D by a factor of 2.5 and increase its investment in R&D in higher education by a factor of three. Secondly, there is a need to develop substantial measures to promote high-tech entrepreneurship. These measures would need to be backed by substantial public resources but – like other support for applied R&D – could be repayable if the supported development was successful. Finally, it would be advantageous particularly for indigenous Irish companies if Ireland could establish bi-national R&D agreements similar to the Israeli-US BIRD agreement. These agreements tend to promote positive strategic partnerships and can act as a valuable introduction to exporting and international collaboration. Again like the BIRD scheme any assistance provided to companies should be repayable if the development proves a success.

Figure 1: Foreign Direct Investment Flows into Israel and Ireland



Sources: Ireland: 1976-86, Table 30b of National Income and Expenditure, CSO Dublin. Post 1986 figures provided by CSO. Irish figures are a two-period moving average. Israel: Table 6.A.13a Bank of Israel, 1996.

Figure 2: Israeli Defence Budget as a Percentage of GNP



Source: Table 1, Inbar, 1998, p.78.

Table 1: Growth and Performance of High-Tech Industry in Ireland and Israel: 1989-95

	Ireland		Israel	
	1989	1995	1989	1995
Exports from Turnover (%)				
All manufacturing	60.7	64.4	28.0	25.9
High-tech manufacturing	96.3	91.0	46.8	46.2
Real Turnover per Employee (\$000)				
All manufacturing	218.2	258.5	103.3	127.4
High-tech manufacturing	268.7	313.1	100.5	135.3
Share of High-tech industry (%)				
Employment	19.6	20.7	15.8	15.2
Turnover	24.1	25.1	15.4	16.2
Exports	38.2	35.5	25	28.8

Notes

1. Sales and exports figures are at constant prices (\$1995). Figures for Ireland, originally in £IRL were converted to 1995 prices and then converted to Dollars at the prevailing exchange rate (\$1=£0.62). Figures for Israeli exports were originally in current price dollars. Figures for Israeli sales, originally in NIS, were translated into current price dollars at the prevailing exchange rate to preserve the ratios relating to export shares etc. Both exports and sales series were then translated into 1995 constant prices using a dollar inflation rate reflecting US domestic costs.
2. High-Tech industry in Ireland includes NACE (rev 1) codes 30-33, i.e. the manufacture of electrical and optical equipment. In 1991 there was a change in sectoral definitions. In Israel the high-tech sector includes electrical and electronic equipment (code 25 of the Israeli SIC) and elements of the Miscellaneous manufacturing section (28) covering precision, optical and photographic equipment. Figures for all manufacturing in Israel exclude diamonds.

Sources: Ireland: Annual Census of Production. Israel: Industry in Israel, Ministry of Industry and Trade, Centre for Planning and Economy, Jerusalem.

Table 2: Exports of Selected Electronics Products: 1996

	Export Value \$m	Percent of Exports	World Export Share (%)
A. Israel			
Office Machines	2.49	0.06	0.0
Computer Equipment	602.64	15.19	0.5
Office Equip Parts/Accs.	245.35	6.18	0.3
Television Receivers	7.77	0.20	0.0
Radio Broadcast Receiver	130.62	3.29	0.9
Sound/Tv Recorders Etc	11.03	0.28	0.1
Telecomms Equipment Nes	1653.57	41.67	1.5
Elect Power Transmission Equip	45.53	1.15	0.2
Electric Circuit Equipment	304.11	7.66	0.5
Electrical Distribution Equip	55.53	1.40	0.2
Medical Etc Diagnostic Equip	217.74	5.49	1.7
Domestic Equipment	18.58	0.47	0.1
Valves/Transistors/Etc	411.19	10.36	0.3
Electrical Equipment Nes	262.19	6.61	0.4
Total	3968.348	100	0.5
B. Ireland			
Office Machines	29.40	0.20	0.2
Computer Equipment	6177.02	41.60	4.9
Office Equip Parts/Accs.	4007.31	26.99	4.8
Television Receivers	5.13	0.03	0.0
Radio Broadcast Receiver	2.12	0.01	0.0
Sound/Tv Recorders Etc	19.74	0.13	0.1
Telecomms Equipment Nes	972.42	6.55	0.9
Elect Power Transmission Equip	144.47	0.97	0.7
Electric Circuit Equipment	650.52	4.38	1.1
Electrical Distribution Equip	311.25	2.10	1.3
Medical Etc Diagnostic Equip	15.28	0.10	0.1
Domestic Equipment	316.46	2.13	1.2
Valves/Transistors/Etc	1780.39	11.99	1.1
Electrical Equipment Nes	418.56	2.82	0.6
Total	14850.05	100.00	2.0

Notes: Export shares are calculated in thousand US dollars at current prices. Product categories are the following SITC three digit groupings: Office Machines, 751; Computer Equipment, 752; Office Equip Parts/Accs., 759; Television Receivers, 761; Radio Broadcast Receiver, 762; Sound/Tv Recorders Etc, 763; Telecomms Equipment Nes, 764; Elect Power Transmission Equipment, 771; Electric Circuit Equipment, 772; Electrical Distribution Equip, 773; Medical Etc Electrical Diagnostic Equipment, 774; Domestic Equipment, 775; Valves/Transistors/Etc, 776; Electrical Equipment Nes, 778.

Source: International Trade Statistics Yearbooks, United Nations Statistical Office, New York.

Table 3: Characteristics and Innovation Indicators for High-Tech Companies in Ireland and Israel: By Ownership Category, 1995

	Israel		Ireland	
	Local	External	Local	External
Number of Plants	78	8	31	66
1. Plant Characteristics				
Employment (no of employees)	101**	216	119**	285
Turnover (\$m, average)	13.9	11.4	15.9**	67.2
Exports (\$m, average)	9.9	10.9	8.9**	46.1
Turnover per emp (\$000, avg)	86.3	80.9	128.5**	242.5
Turnover growth (3 years)	22.6	33.1	59.8	89.6
Date of foundation (avg)	1980	1981	1976	1982
2. R&D and Innovation Indicators				
Percentage of graduates	29.0*	47.4	13.8	12.2
Undertaking R&D (% plants)	100.0	100.0	66.7	43.1
R&D expenditure (\$m, avg)	1.3**	10.9	0.09*	0.31
R&D per sales (%)	28.3	43.1	1.3	0.9
Innovation indicator (% plants)	70.5	87.5	54.8**	75.8

Note: ** denotes a significant difference between means for local and externally owned businesses at the 5 per cent level. * denotes a significant difference at the 10 per cent level.

Sources: Company Survey Data. See Shefer and Frenkel (1998), Roper and Hewitt-Dundas, 1998.

Table 4: Largest Twenty Companies in the Israeli Electronics Industry (by Employment): 1997

	Company	Empl.	HQ Location	Main Business Areas
1	Tadiran Ltd	5300	Israel	Military and Commercial Telecomms, Electrical Appliances
2	Israel Aircraft Industries Ltd- Electronics Group	5200	Israel	Military and Commercial Missile and Communication Systems
3	Rafael - Armament Development Authority	3800	Israel	Military Missile and Weapon Systems
4	Motorola Communications Israel Ltd	3500	USA	Communication and Control Equipment
5	Scitex Corporation Ltd	3400	Israel	Digital Printing and Video Equipment
6	ECI Telecom Ltd	3100	Israel	Networking and Telecommunications Equipment
7	Telrad - Telecomms d Electronic Industries Ltd	3100	Israel	Telecommunications Networks, Data Systems etc
8	Vishay Israel Ltd	3000	Israel	Passive Components
9	Tadiran Telecommunications Ltd	2650	Israel	Telecommunications Equipment and Systems
10	Elta Electronics Industries Ltd	2375	Israel	Military Radar and Communication Systems
11	Motorola Israel Ltd	1870	USA	Radio Communications, Data Transmission Equipment
12	El-Op Electro-Optics Industries Ltd	1800	Israel	Thermal Imaging Systems
13	Elscint Ltd	1820	Israel	Medical Imaging and Diagnostic Equipment
14	Efrat Future Technology Ltd	1800	Israel	Message Management Systems
15	Elbit Systems Ltd	1760	Israel	Electronic Defence Systems and Products
16	Orbotech Ltd	1100	Israel	Optical Inspection Systems for PCB Manufacture
17	Intel Israel (74) Ltd	1000	USA	Development of Microprocessors
18	Jerusalem Intel Electronics Ltd	900	USA	Manufacture of Microprocessors etc
19	Elisra Electronic Systems Ltd	805	Israel	Airborne Defence Systems, Simulators
20	Indigo	800	Israel	Electronic Printing Products

- Notes**
1. The table excludes holding companies Elron electronic industries Ltd and Elbit Ltd..
 2. Employment figures for Electro Optics and Efrat Future Technologies relate to their world-wide operations.

Source: Association of Electronics Industries (1998).

Table 5: Largest Twenty Companies in the Irish Electronics Sector (by Employment): 1997/98

	Company	Empl	HQ Location	Business Area
1	Intel Ireland Ltd	2650	US	Integrated Circuits
2	Glen Dimplex	2000	Ireland	Domestic Electrical Appliances
3	L M Ericsson Holdings Ltd	1985	Sweden	Telecommunications Equipment
4	Motorola BV	1894	US	Radios/Pagers
5	Apple Computer Ltd	1800	US	Computers
6	Hewlett Packard	1730	US	Ink Jet Printers and Components
7	Dell Products Europe	1700	US	Computers
8	Analog Devices	1250	US	Electrical Components
9	Braun Ireland Ltd	1000	Germany	Personal Care Items
10	Kostal Ireland	1000	Germany	Automotive Electronics
11	SCI Ireland Ltd	1000	US	Electronics Contract Manufacture
12	General Semiconductor Ireland	730	US	Electronic Components
13	Dovatron Electronics (Ireland) Ltd	700	US	Electronic Sub-assembly
14	American Power Corporation (APC)	700	US	Power Supplies
15	Kromberg and Schubert Ireland Ltd	600	Germany	Cable Harness
16	Krups Engineering Ltd	600	France	Electrical Appliances
17	Molex Ireland Ltd	600	US	Electronic Components
18	Wexford Electronix Ltd	525	Ireland	Cable Harness
19	NEC Semiconductors Ireland	500	Japan	Integrated Circuits
20	Bourns Electronics (Ireland) Ltd	500	US	Electronic Components

Table 6: Selected Science and Technology Indicators

	Israel	Ireland
Civilian R&D (GERD) (% of GDP)	2.4	1.4
Business R&D (% of GDP)	1.08	0.99
Higher Education R&D (% of GDP)	0.83	0.27
Government R&D (% of GDP)	0.26	0.14
Govt Funding of civil BERD (%)	26.1	10.0

Notes and Sources

1. GERD - Israel: 1994, Statistical Abstract of Israel, Tables 23.1 and 6.1. Other Areas: Main Science and Technology Indicators, Table 6.
2. Breakdown of R&D by operating sector. Figures for Ireland relate to all R&D. Figures for Israel relate to civil R&D only. Total is not the sum of the other columns due to the exclusion of R&D undertaken by private non-profit making institutions. Sources as GERD.

Table 7: Educational indicators: 1994/95

	Israel	Ireland
Avg enrolment rates 3 rd level	41.1	37.0
Spending on Education (% of GDP)	6.6	6.3
Students per 100,000 population	3598	3443
Higher degrees as % first degrees		
All Subjects	39.7	51.4
Sciences	45.9	41.1
First Degree	11144	11802
Of which (%):		
Natural Sciences	8.5	16.9
Maths and Computer Science	4.6	4.7
Medical, Health Related	9.4	5.1
Engineering	13.8	10.7
Higher Degrees	4429	6076
Of which (%) :		
Natural Sciences	16.3	10.1
Maths and Computer Science	3.8	6.2
Medical, Health Related	10.6	5.5
Engineering	11.2	8.2

Note: Expenditure and enrolment figures 1995. Analysis of degree by level and subject for Israel relates to 1993. Figures for Ireland relate to 1994.

Source: UNESCO Statistical Yearbook, 1997.

**Table 8: Labour Cost and Productivity Indicators for Electronics Manufacture:
Israel and Ireland: 1994**

	Labour Cost per employee \$000	Output per employee \$000	Value Added per employee \$000	Investment per employee \$000
A. Ireland				
Electrical Machinery	22.6	282.1	90.4	17.5
Professional, Scientific and Measurement Equipment	21.4	120.6	75.8	6.6
B. Israel				
Electrical Machinery	34.5	115.4	48.3	7.1
Professional, Scientific and Measurement Equipment	30.8	88.8	41.0	4.3

Note: Figures for Israel are as originally given for ISIC revision 2 categories 383 and 385. Category 383 includes electrical and industrial machinery, radio and television equipment and electrical appliances. Category 385 includes measurement and control equipment, photographic and optical equipment and watches and clocks. Figures for Ireland are aggregated ISIC 3 categories at the 4-digit level. ISIC (2) category 385 is equated to ISIC (3) category 331 (medical, scientific and measuring Equipment). ISIC (2) category 383 is equated to the sum of ISIC (3) categories 3000, 3110-3190 and 3210-3230. Figures in national currencies were converted to \$ using 1994 average exchange rates.

Source: International Yearbook of Industrial Statistics, UNIDO, 1998.

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