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Financing R&D in Mature Companies: An Empirical Analysis

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Abstract

R&D intensive firms are often described as (1) relying mainly on equity financing; (2) investing primarily in intangible assets; (3) exhibiting a high market to book ratio (a high Tobin's q); and (4) as being young and fast growing. We put this commonplace characterization to a systematic empirical test and ask if R&D intensive firms rely mainly on external funding, and if so, whether it is mainly stock market funding. For our sample of Israeli manufacturing firms that issued stock in the 1990s, we present, for the first time, adjusted Flow of Funds charts that treat R&D expenses as a capital outlay (rather than an operating cost that reduces profits, as standard accounting principles prescribe). Our results indicate that the characterization is only partially appropriate for established firms engaged in R&D. Israeli R&D intensive firms that are traded on the Tel Aviv stock exchange indeed rely more on equity financing and exhibit a high market to book ratio, are younger but not faster growing than average, and do not invest primarily in intangible assets. In fact, they exhibit slower sales growth than average, and invest in physical capital more than average. Our analysis also suggests that classifying firms as "R&D intensive" on the basis of the personnel they hire - a common practice in statistical bureaus - may not be ideal. Finally, we study the patterns of government aid for R&D.

Key words: R&D, equity financing, cash flow, government grants and subsidies

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1. Introduction

In recent years, Israel has become a world center of R&D and technological innovation. Much of this activity is carried out in mature firms that are often publicly traded on a stock exchange. These firms have access to a variety of financing sources and, in addition, are eligible for government subsidies for R&D. We investigate whether and in what respect these firms are special and, in particular, whether they are financed differently from other firms. This should help us to gain a better understanding of the factors, financial and other, that affect R&D activity.

R&D intensive firms are often described as (1) relying mainly on equity financing; (2) investing primarily in intangible assets; (3) exhibiting a high market to book ratio (a high Tobin's q); and (4) as being young and fast growing. One task we undertake is putting this commonplace characterization to a systematic empirical test. In particular, we ask if R&D intensive firms rely mainly on external funding, and if so, whether it is predominantly stock market funding or other funding.

In many countries, the government subsidizes R&D in various ways. Israel is no exception; indeed the level of direct funding is relatively high and numerous seasoned firms obtain R&D grants.[1] A goal of this paper is to profile the firms that obtain government R&D aid in terms of, e.g., size, age, profitability, physical capital intensity, and R&D activity. Such information can help assess the effectiveness of the government's R&D policy.

To achieve these goals, we exploit and enhance two unique firm-level datasets constructed recently. The first (and much larger) dataset includes a year-by-year Flow of Funds chart for more than 250 manufacturing firms traded on the Tel Aviv stock exchange for the period 1990-

1997.[2] It has been augmented here to include Flow of Funds information regarding an additional 70 Israeli firms traded on U.S. exchanges.[3] We combine these data into a single dataset, thereby encompassing virtually the entire universe of Israeli publicly traded manufacturing firms.

We present, to our knowledge for the first time, firm-level year-by-year adjusted Flow of Funds charts that treat R&D expenses as a *capital outlay* (rather than an operating cost that reduces profits, as standard accounting principles prescribe). These adjusted Flow of Funds charts allow us to study how R&D investment is financed across firms and over time, and whether R&D intensive firms exhibit particular financing patterns.[4] We further calculate firm-specific "beta's" and excess returns for the stocks of these companies, allowing us to study whether high R&D intensity is associated with better stock market performance.

To measure R&D intensity, we rely on firm-level R&D expenses as reported in their public annual reports.[5] Another measure of R&D intensity is the percentage of employees engaged in R&D.[6] We construct both measures for each firm in our sample and investigate to what extent they are mutually consistent, an issue that, to our knowledge, has not been studied before. We find, for example, that firms that do not report R&D expenses but employ personnel engaged in R&D do not carry out research or product development as defined by

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[1] Much aid for R&D is directed to universities and to start-ups. We do not study these important channels of R&D subsidization; see Trajtenberg (2000).
[2] See Blass and Yosha (2001).
[3] See Blass and Yafeh (2001).
[4] Bound et al. (1984) similarly describe the construction and merging of various datasets of publicly traded manufacturing firms in the United States but they do not address the issue of funding.
[5] In Israel, such data are collated as part of the Manufacturing and Crafts Surveys conducted by the Central Bureau of Statistics (unreported) and the Survey of Research and Development in Manufacturing published by the Central Bureau of Statistics. In the United States, such data are published by Compustat. For certain years, such data are also available in surveys conducted by the United States National Science Foundation; see Bound et al. (1984, p.26) for a discussion.
[6] In Israel, firms report this information as part of the Survey of Research and Development in Manufacturing published by the Central Bureau of Statistics, but these data are publicly available only at the aggregate level. In this study we use firm-level data that were collected from securities offerings prospecti.

official accounting standards. In these firms, the personnel reported as engaged in R&D performs activities such as quality control, that should not be recorded as R&D expenses. Therefore, for the purposes of this study, reported R&D expenses are more meaningful.[7] We further compare the R&D intensity (and other relevant information) in our sample to Israeli national-level data published by the Central Bureau of Statistics and the Chief Scientist at the Ministry of Industry and Trade.

We then turn to the main analysis, and characterize the firms in our sample that are R&D intensive in terms of industry, age, size, geographical location, and profitability. To address the issue of R&D *financing*, we use the adjusted Flow of Funds data to calculate, for each firm-year observation, the ratios of internal funds, debt, equity, and government financing (capital grants, R&D grants, and deferred taxes), as a fraction of total sources and, similarly, the ratios of capital expenditure, investment in inventory, investment in liquid assets, investment in R&D, and dividend payouts, as a fraction of total uses. We further compute, for each firm-year observation, standard profitability ratios such as net profits to sales and net profits to equity, as well as year-by-year Tobin's q.

We then examine whether R&D intensive firms rely more on equity financing, bank credit, government assistance, or internal funds, whether they differ in terms of uses of funds other than R&D, and whether they exhibit higher accounting profitability. We also study the determinants of investment in R&D and whether (lagged) Tobin's q is a determinant of such investment. Finally, we evaluate the relative stock market performance of R&D intensive firms.

2. Data construction, variable definition, and descriptive statistical analysis

[7] The Israeli Securities Authority and the U.S. SEC provide very precise (and quite strict) guidelines for reporting R&D expenditures (see Section 2).

In this section, we describe the sample of firms, the raw data sources, and the procedure for constructing firm-level year-by-year Flow of Funds. We then explain our definition of R&D intensity and compare with another method used in the literature. With the aid of these data, we characterize the financing patterns of the firms in the sample. Finally, we calculate firm-level year-by-year Tobin's q and check whether the q of R&D intensive firms is different than average.

General description of the sample

The sample consists of about 250 Israeli manufacturing firms that are listed on the Tel Aviv stock exchange,[8] and an additional 70 Israeli firms traded on U.S. exchanges (a total of 321 firms). We follow the sample for 8 years, from 1990 to 1997. Almost two thirds of these firms went public during the 1990s, while most of the other firms who had been listed prior to the 1990s issued more stock during the last few years, particularly in 1992 and 1993.

The sample includes most large Israeli manufacturing firms in electronics and chemicals (including pharmaceuticals), the sub-sectors in which most R&D is performed.[9] Of the 50 largest firms in these sub-sectors in 1997 (by sales), 36 are in our sample either directly or as subsidiaries of publicly listed firms. (The remaining firms are privately held.) Moreover, these 36 firms represent 73 percent of sales of the 50 largest firms in the above sub-sectors. We conclude that our sample of publicly traded manufacturing firms is reasonably representative of the nation-wide manufacturing sector.[10]

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[8] In the official Tel Aviv stock exchange classification by industry, the category "manufacturing" includes venture capital firms and holding companies. To preserve the (relative) homogeneity of the sample, these firms are not included in the sample.

[9] Electronics includes communication equipment, medical and scientific equipment, electronic components, hardware, some types of software, and more, while chemicals include pharmaceutical, refining, paints, plastics, and more. In our sample, 63 percent of R&D expenditure is by firms in electronics and 22 percent in chemicals.

[10] The sample of publicly traded manufacturing firms is not representative of the so-called "start-up" firms that *only* perform R&D and are often backed by venture capital. The findings and conclusions of this study do not apply to such firms.

Data sources

For each firm, data were collected from four key sources: (1) financial statements obtained mostly from a Compustat-type database ("Dukas") compiled by the Tel Aviv stock exchange from annual reports; (2) stock price data; (3) prospecti submitted by firms issuing equity (IPOs or seasoned offerings) during the 1990s; and (4) flow statements compiled by the Bank of Israel Research Department from annual reports. In addition, we collected data on geographic location and firm age (mostly from firm prospecti).

Financial statements data

The Dukas database contains information on all the securities listed on the Tel Aviv stock exchange. Because Dukas contains just four or five years of data at any point in time, it was necessary to reconstruct early financial statements figures by matching current and older versions of Dukas. Since firms that go public are required to provide financial statements for two years prior to the IPO, our sample includes pre-IPO data for such IPOs (more than half of the sample).

Stock price data

The Tel Aviv stock exchange provides daily data for all securities listed on the exchange. The data include price changes, number of shares outstanding, year of IPO and dividend information. The data have been stored and accumulated by the Bank of Israel Research Department and allow us to compute a firm's market value at any point in time. Data for stocks listed in the United States have been mainly entered by hand from daily newspapers. We use these data for calculating firm-level Tobin's q, stock "beta's," and stock excess returns.

Prospecti

We collected data from prospecti submitted to the Israeli Securities Authority (and the U.S. SEC) in which firms issuing equity are required to provide information about their lines of business, future prospects, business risks, ownership structure, geographic locations of plants and markets, R&D expenses, year of incorporation, and distribution of employees' occupations.

Since most firms issued equity during the 1990s, either for the first time as IPOs or as a seasoned offering, the data are available for the overwhelming majority of firms.

Flow statements

The Bank of Israel Research Department has collected the 1990 through 1997 annual reports for listed firms and entered by hand for each firm and each year the "Consolidated Flow Statement." The statement decomposes the change in a firm's balances into flows derived from operating activities, investment activities, and financing activities (broken down into up to 50 sub-entries). This information allows us to construct a Flow of Funds for each firm-year in the sample.

In order to summarize the information contained in the flow statements, the approximately 50 types of entries provided in the statements were combined into 10 broader groups. Four - internal funds, net stock issues,[11] net increase in debt, and government financing - can be viewed as alternative sources of capital; six - capital expenditure, R&D expenses, the increase in inventories, in working capital, in liquid assets, and dividend payments can be viewed as uses.

For each firm-year observation, we compute the ratios of these sources and uses to total sources, as well as standard profitability ratios such as net profits to sales and net profits to equity.

Removing outliers

We removed from the sample firm-year observations in which we identified inconsistencies between the Dukas database and flow statements entered by hand.[12] We also removed firms which were extreme outliers in terms of the average (over time) of one or more source ratio, use

[11] Convertible bonds are treated here as equity, even though the interest on such bonds appears as an expense (and not as a dividend payout).

[12] In this procedure, we used four key variables: net profits, flows from investment activities, flows from financial activities, and flows from operations. A discrepancy of 5 percent (provided it is greater than 5000 December 1990 NIS) in one or more of these variables led to the removal of the firm-year observation from the sample. 296 firm-year observations were removed for this reason.

ratio, or profitability ratio.[13] We further removed firm-year observations for which total sources were negative,[14] firms for which there are only one or two observations (9 firms), as well as firms for which the time-average of total sources was negative (13 firms). Finally, in the regressions displayed in Tables 6 and 7 (but not elsewhere) we removed from the sample 15 firms that paid royalties to the government (63 firm-year observations) because, for some of these firms, government R&D grants less royalties are negative. Interestingly, the firms that pay royalties represent only about 10 percent of firms receiving grants which suggests that a large portion of government funded R&D projects are unsuccessful.[15]

Measuring R&D intensity

We define R&D intensity as the ratio of R&D expenses (reported in annual reports) to total uses. To illustrate, consider the 50 largest manufacturing firms in electronics and chemicals (including pharmaceuticals). As mentioned, 36 of these firms are publicly traded and are included in our sample, of which 25 report R&D expenses. The largest firm, the Oil Refineries, does not report R&D expenses, but the next largest 11 firms (4 chemical, 1 pharmaceutical, and 6 in electronics) all report R&D expenses. Two privately held firms are very large and spend considerable resources on R&D (Israel Aircraft - the second largest, and Motorola Israel - fifth).

We contrast this expense-based measure of R&D intensity with the measure based on the percentage of employees engaged in R&D activities obtained from prospecti of IPOs and seasoned equity offerings; see Exhibit A. The correlation between the two measures is reasonably high, with 94 firms (out of 238 firms for whom we have data on workforce

[13] Consider some ratio, x, compute the average of x over the sample years for a particular firm, and denote this average by x'. Repeat for all the firms in the sample, and compute the average of x' across firms, denoted x". Firms for which x' minus x" was larger than four standard deviations (of x'), for one or more source ratio, use ratio, or profitability ratio were removed from the sample. 49 firm-year observations were removed for this reason.

[14] 216 firm-year observations were removed for this reason.

[15] On average, these firms do not exhibit any special features. None operate in development areas, and only two are traded in the United States. This group includes one outlier - Scitex - which is considerably larger, more profitable (during the sample period), and relies more on internally generated cash than other firms in the group (and in the sample in general).

composition) both reporting R&D expenses and employing R&D personnel, 78 firms not reporting R&D expenses nor employing such personnel, and only 17 firms reporting R&D expenses without employing personnel specializing in R&D. Approximately one fifth of the firms (49 out of 238) report zero R&D expenses, yet employ engineers and other research-type personnel. This requires investigation. In particular, the question arises whether R&D spending may be understated since it would seem that these 49 firms might actually be conducting R&D. If so, some of the 57 firms for whom no employment data are available and report no R&D spending might also be conducting R&D.

Exhibit A – Reporting of R&D Expenses in Annual Reports
versus Percentage of Employees in R&D from Prospecti

R&D employees in prospectus	Reporting R&D expenses in annual reports	
	YES (# of firms)	NO (# of firms)
YES (# of firms)	94	49
NO (# of firms)	17	78
Unknown (no prospectus)	26	57

To address this issue, we study in detail the type of activities undertaken by the 49 firms employing R&D personnel but not reporting R&D expenses. We first discuss the accounting and legal guidelines according to which publicly listed firms report R&D.

Israeli accounting practices generally conform to the accounting standards of the Financial Accounting Standards Board (FASB) in the United States. According to FASB Statement 2, R&D costs are charged as an expense (rather than an investment) when incurred. Research is defined as a "planned search or critical investigation aimed at discovery of new knowledge with the hope that such knowledge will be useful in developing a new product…or a new process or in bringing about significant improvement to an existing product or process." Development is defined as the "translation of research findings...into a plan or design for a new product or process or for a significant improvement to an existing product or process…"

According to the FASB, the types of activities that typically would be included as a research and development expense include:

1. laboratory research aimed as discovery of new knowledge;
2. searching for applications of new research findings or other knowledge;
3. formation, design, modification, engineering activity and testing of product or process alternatives;
4. design, construction and testing of prototypes, models, pilot plants and tools (involving new technology).

By contrast, other related activities would not be recorded as an R&D expense, but as a cost of production:

1. engineering follow through in an early phase of commercial production;
2. quality control and trouble shooting during commercial production;
3. improvement upon the qualities of, or periodic changes to existing products;
4. adaptation of capabilities to a customer's needs;
5. routine design of tools;
6. design and construction engineering related to start-up of facilities or equipment.[16]

As mentioned, we analyze the activities of the 49 firms that report R&D employees but do not report R&D spending in their annual reports (Exhibit A). A number of interesting results

[16] The banning of the capitalization of R&D expenses in the United States occurred in 1975. Horwitz and Kolodny (1981) discuss the effects of this decision. Among these are, as might be expected, a relative reduction in book equity, higher leverage, and effects on firms meeting security listing requirements. Horwitz and Kolodny further found that the decision caused a reduction in R&D spending by small firms. In many countries, R&D capitalization is allowed and even required. In the United Kingdom, for example, SSAP requires that development expenditures be deferred (but not pure and applied research). An international comparison would be an important project in its own right.

are observed:

1. These firms are not engaged in research or product development but rather in activities such as quality control that should not be recorded as R&D expenses as indicated by the FASB. We combed through the prospecti of 39 of these 49 firms and spoke to the management in a few cases where questions remained: in 33 cases, the R&D-type personnel were engaged in quality control or improvement, technical supervision, or periodic changes to existing products as well as adaptation of capabilities to a customer's needs. Six of the firms indeed engaged in R&D and in their prospecti (but not in their annual reports) R&D expenses are in fact provided in the appended notes. In these cases, however, the expenses are miniscule - less than 3 percent of total uses.[17]

2. The number of employees engaged in such activities in these firms tends to be low, both in absolute numbers (approximately 15) and as a percentage of the entire workforce.

3. The breakdown of these firms by industry is different than that of firms reporting R&D expenses - whereas 81 out of 94 firms employing R&D-type personnel and reporting R&D expenses are in electronics, only 11 out of the 49 not reporting R&D expenses but with R&D-type personnel are in electronics.

It should also be noted that according to the Securities Law (Chapter 6, par. 47), Israeli corporations are required to itemize R&D expenses as a separate expense and not to co-mingle them with "other expenses" if they are greater than 5 percent of net profits.

Overall, the evidence suggests that firms that do not report R&D spending, to the extent that they do in fact engage in R&D, do so to a very limited extent. We conclude, that for the purposes of this study, reported R&D expenses are more meaningful than employment in R&D as

[17] Each of these cases was recorded prior to 1993.

a measure of R&D intensity.[18] In light of the extensive government support to R&D intensive firms in many countries, it is important to measure correctly R&D intensity. Whether our conclusion - that the expense-based measure is superior - carries over to other settings and other countries is a worthy topic for research with obvious policy implications.

Who reports R&D spending and who receives R&D government funding?

In our sample, 109 firms report R&D expenses at least once. All of them except 10, report R&D expenses at least half of the time. 80 percent of R&D spending in our sample is conducted by one third of the firms. As mentioned, most of the R&D spending is recorded in electronics (63 percent) and chemicals and pharmaceuticals (22 percent).[19]

In 26 percent of firm-year observations, government funding (net of royalties) amounts to more than 30 percent of R&D expenses, while no government funding is provided in 23 percent of the observations. Over time, the percentage of firms receiving more than 30 percent funding has declined, in part because of increased payment of royalties. On average over the sample years, 34 percent of government R&D subsidies are granted to the firms in our sample.

U.S. R&D firms, local R&D firms, and zero R&D firms

In light of the large differences between Israeli firms that issue securities in the United States and those that issue only in Tel Aviv (see Blass and Yafeh 2001), we chose to perform the analysis in terms of three groups of firms: those that report R&D expenses and issued stocks in the United States (U.S. R&D firms), those that report R&D expenses and issued stocks only in

[18] The following caveat is in order. As mentioned, the R&D expenses are from annual reports whereas the R&D employment numbers are from prospecti. If, for example, a firm does not employ R&D personnel at the time of a securities offering but later hires such personnel, our data for this firm several years after the offering will say that it reports R&D expenses but does not employ R&D personnel. If indeed this is the source of the discrepancy between the two R&D intensity measures, the measure based on R&D expenses reflects more closely the firm's year-by-year R&D activities. (In other studies, R&D personnel data is typically from prospecti, as in our sample, and not on a year-by-year basis.)

[19] The dominance of electronics in R&D expenditure is consistent with the Survey of Research and Development in Manufacturing, 1996, published by the Central Bureau of Statistics.

Tel Aviv (local R&D firms), and those that do not report R&D expenses throughout the sample (zero R&D firms).[20] On average over the sample years, 21 percent of government R&D subsidies are granted to the U.S. R&D firms and 13 percent to the local R&D firms in our sample. There are striking differences among these groups as a straightforward descriptive statistics analysis reveals.

Descriptive statistics

Table 1 displays descriptive statistics.[21] The number of firms ranges from about 120 in 1990 to about 200 in 1998. It is immediately apparent that (publicly traded) R&D intensive firms are large, not small as is commonly perceived. They are younger than average, especially those that issued stocks in the United States. It is interesting that R&D intensive firms are much more profitable, in particular those that issued stocks in the United States. This finding is in sharp contrast to the virtually ubiquitous view that regards R&D firms as currently non-profitable (but with high expected future profits). In calculating profitability, R&D is *not* regarded as a capital outlay (rather than as an expenditure) as we do for calculating Flow of Funds, suggesting that the true profitability of R&D intensive firms is even greater than that reported in Table 1.

U.S. R&D firms exhibit a lower leverage ratio, which is consistent with the interpretation that Israeli firms regard equity financing in the United States as an effective alternative to local bank funding. This is not so for local R&D firms possibly because Israeli banks are still quite dominant in local financial markets, including the stock market; see Yafeh and Yosha (1998), Blass, Yafeh, and Yosha (1998), Ber, Yafeh, and Yosha (2001), and Blass and Yosha (2001).[22]

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[20] We also include in the zero R&D group nine firms that did not report R&D expenses in most years and for whom R&D expenditures (whenever reported) represented less than 1.5 percent of all uses.

[21] Here, and in what follows, the above mentioned outliers are not included.

[22] The lower leverage ratio is not a consequence of differences in usage of corporate bonds - Israeli firms raise negligible amounts of funding in this manner (a puzzle in its own right); see Yafeh and Yosha (1998) and Blass and Yosha (2001).

A striking finding is that local R&D firms are heavily concentrated in development areas (for simplicity defined in our analysis as firms located in telephone area codes 06 and 07) whereas U.S. R&D firms are conspicuously *not* located in these areas. Location seems to be endogenous and responsive to financing opportunities: the Israeli government is willing to subsidize employment and investment in the periphery areas whereas U.S.
investors are more impressed with centrally located firms, and corporations respond accordingly.[23,24]

Constructing Flow of Funds adjusted for investment in R&D

In order to summarize the information contained in the flow statements we combined the approximately 50 types of entries provided in the statements into 10 broader groups. Four sources of funds: internally generated cash, net stock issues, net increase in debt, and net government aid (capital grants, R&D grants, and deferred taxes less royalties); and six uses of funds: capital expenditure, the increase in inventories, in working capital (other than inventory), in securities, in cash or cash equivalents, and dividend payments.

The R&D expenses reported in Dukas are net of government aid for R&D and, therefore, underestimate the actual expenditure on R&D. To correct for this, we scanned the annual reports by hand for firm-level year-by-year net government aid for R&D (i.e., net of royalties paid to the government). We then added this amount to R&D expenses as reported in Dukas obtaining gross R&D expenditures, which is defined as a use. Since net government aid for R&D is a source, we added it to total sources. This is essence of the adjustment of the Flow of Funds constructed in Blass and Yosha (2001) where R&D is treated as an expense that reduces profits

[23] It should be kept in mind that firms seeking funding in the United States benefit from reduced tax payments.

[24]This brings to mind the issue of spillovers. Suppose that R&D intensive firms benefit from clustering. If some firms seek financing from U.S. investors but others do not, they would not locate in the same area - those who do not seek funding abroad will move to development areas to benefit from government assistance whereas those who seek funding abroad remain in the center to accommodate the tastes of U.S markets. This may reduce the degree of geographic clustering and diminish the benefits from inter-firm spillovers.

(and hence total sources), and government aid for R&D is ignored (and therefore omitted from total sources).

Sources

Sources are displayed in Table 2. Internally generated cash is calculated by adding depreciation (a non-cash expense) to net income and then further adding and subtracting several additional components. These include expenses, such as deferred employee benefits, and revenue, such as unrealized gains on marketable securities, that are included in the calculation of net income but do not involve cash flows. R&D intensive firms (in both classes) rely more on external funds. U.S. R&D firms rely considerably more on equity issues (defined as total proceeds received from floatation of common stock, convertible bonds,[25] and warrants as well as proceeds received from exercise of warrants and options). This is fully consistent with the view that arm's length finance (stock market finance) is more suited for financing R&D (see Allen 1993). Local R&D intensive firms do not rely on stock floatation and rely, instead, on debt (mostly bank debt) and on government aid considerably more than firms that do not perform R&D. Their reliance on equity financing suggests that R&D intensive firms - whether they issued stock in Israel or abroad - are less dependent on bank financing, although the banks in Israel were heavily involved in securities offerings on the Tel Aviv stock exchange as underwriters and as buyers of securities (mainly through investment funds); see Blass, Yafeh, and Yosha (1998) and Ber, Yafeh, and Yosha (2001).

Uses

Uses are displayed in Table 3. Capital expenditures include investments (net of sales) in property, plants, and equipment. Investment in working capital (other than inventory) is defined as an increase in current assets, such as trade accounts receivable, less current liabilities, such as trade accounts payable. These adjustments correct for the fact that sales recorded on the income statement might overstate (or understate) actual cash receipts since part of the proceeds from

sales might not be received by the end of the year. An offsetting effect occurs if payments for materials and services used in production are delayed, in which case accounts payable will increase, and that increase needs to be added to net income. Investment in cash and securities is defined as a net change in cash holding plus a purchase of publicly traded securities and mutual funds.

The local R&D intensive firms stand out as heavily investing in fixed capital, devoting three times as many resources to capital expenditures than R&D. Indeed, in every year of our sample these firms devoted greater resources to capital expenditures than R&D. Is this indication that R&D investment and capital expenditure are complements (an unlikely interpretation in light of the very different numbers for U.S. R&D firms)? Or do these firms simply "specialize" in obtaining government aid of all sorts? We have no hard evidence regarding this issue, but its potential policy implications are far reaching.

The three categories of firms differ somewhat insofar as inventories are concerned (we do not have an obvious interpretation). U.S. R&D firms differ significantly from the other firms as they devote 36 percent of funds to increasing cash balances and securities holdings, reflecting the large amounts of cash raised during the stock offering.[26] The three groups differ significantly in their dividend payout polices. The zero R&D group pays out the largest fraction of funds, and the variation over time in this category is very small.

Calculation of Tobin's q

We measure firm-level year-by-year Tobin's q as the market value of assets divided by their replacement value. Replacement values are calculated assuming that fixed assets and inventories appreciate at a rate equal to that of the consumer price index (CPI). The market value of assets equals the market value of common equity plus the value of debt. The latter is calculated as the

[25] Convertible bonds contain both debt and equity features and are treated here as equity, even though the interest on such bonds appears as an expense (and not as a dividend payout).

replacement value of assets less the sum of the book value of common equity and (CPI adjusted balance sheet) deferred taxes and employee benefits. (We do not construct an estimate of R&D stock, and "replacement value" refers to physical capital.)

Table 4 displays the year-by-year unweighted average of firm-level Tobin's q for the firms in the sample. For local R&D and zero R&D firms, Tobin's q so calculated rises dramatically in 1992 and 1993 reflecting the stock price run-up in those years. For zero R&D firms it declines in 1996, and when market conditions improved in 1997 it rises again. Tobin's q of local R&D firms does not decline in 1996 and rises substantially in 1997. On average (and in most years), Tobin's q of local R&D firms exceeded that of zero R&D firms.[27] For the U.S. R&D firms, Tobin's q declined most in 1996, but in every year it was above that of the zero R&D and local R&D firms. This suggests that the U.S. R&D firms possess many intangible assets that are valued by investors.

3. Empirical Analysis

In this section, we investigate more systematically the regularities suggested by the descriptive statistics presented in the previous section. We begin by studying, using simple linear regression, the determinants of the various source and use ratios using the unique panel of firm-level Flow of Funds data. We then turn to the determinants of R&D intensity using probit analysis. Finally, using simple linear regression with dummy variables for R&D intensive firms, we ask whether the performance of the stocks of these firms is different than average.

Determinants of source and use ratios

Tables 5 and 6 display cross-section regressions of source ratios and use ratios, averaged

[26] In fact, Blass and Yafeh (2001) find that these firms dilute ownership much more than firms that issue stocks in Israel.

[27] This is consistent with Hall (1988) and Johnson and Pazderka (1993) who found a positive relation between R&D spending and stock market value.

over time, on firm characteristics (also averaged over time).[28,29] We include dummy variables for U.S. R&D firms and local R&D firms. The results in Table 5 indicate that large firms and profitable firms rely less on stock offerings. An interpretation is that shareholders of successful companies are not eager to dilute their ownership stakes and share profits with outside investors.

It is interesting that profitable firms rely more on government aid (which includes capital grants, R&D grants net of royalties, and deferred taxes). On the one hand, this indicates that such aid is not wasted on losing companies; on the other hand, it raises the question whether aid reaches those firms who really need it. Firms in development areas depend on government aid (as we would expect) and those in the Tel Aviv area do not rely on such aid. The industry dummies are mostly insignificant (not shown).[30] Older firms rely more on internal sources and less on bank debt. Surprisingly, older firms do not rely less on government aid, which again, raises the question whether such aid is allocated according to true need.

We turn to the coefficients on the U.S. and local R&D firm dummies. R&D firms - both U.S. and local - rely more on government aid.[31] It is also apparent that U.S. R&D firms rely more on stock offerings. By contrast, local R&D firms do not rely on stock offerings. This is fully consistent with the descriptive statistics displayed in Table 2 and, as mentioned, with the view that arm's length finance (stock market finance) is more suited for financing R&D.

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[28] For example, in the first column of Table 5, the dependent variable is the ratio of internally generated cash to total sources.

[29] As mentioned, in these regressions we removed from the sample the 15 firms that paid royalties to the government (63 firm-year observations) because, for these firms, government R&D grants less royalties are often negative.

[30] A notable exception is textiles for which a greater reliance on debt at the expense of internally generated funds is observed.

[31] Clearly, there is a strong correlation between R&D intensity and R&D grants since these grants are distributed on condition that R&D is carried out according to approved plans. We, therefore, do not document this correlation. Such correlation, per se, does not indicate that R&D grants stimulate R&D since we lack information on the counterfactual - what would R&D intensity have been

Table 6 displays the results of an analogous exercise for uses. In the R&D expenditure regression (the second to last column), only U.S. and local R&D firms are used since for all the other firms in the sample R&D expenditure is zero. (Therefore, in this regression the dummy variable for local R&D firms is omitted.) This regression uses only 65 observations, mostly in electronics, and, therefore, industry dummy variables are omitted. Not surprisingly, firms in development areas invest relatively more in fixed assets. Profitable firms invest relatively more in fixed assets *and* tend to devote a greater share of total resources to R&D. Combining this finding with those reported in the previous table, we obtain the following pattern: profitable firms rely on external financing (in particular, government aid) and use these funds for investment both in physical assets and R&D.

Another interesting finding is that, as a fraction of total sources, U.S. R&D firms do *not* invest more in R&D than local R&D firms. This does not necessarily contradict Blass and Yafeh's (2001) finding that Israeli companies that issue stocks in the United States are more R&D intensive than Israeli companies that issue stocks in Tel Aviv. First, they focus on initial public offerings (IPOs) whereas we consider both IPOs and seasoned firms. Second, they measure R&D intensity as the percent of employees in R&D and as the percentage of the IPO proceeds designated for R&D in the IPO prospectus whereas we measure actual investment in R&D as a fraction of total uses. Since total uses for U.S. R&D firms are very big, as a result of the large amounts of equity capital raised, and since a portion of these funds is invested in cash balances, R&D expenditures as a fraction of total uses are not larger than for local R&D firms. Indeed, the regression also confirms that R&D intensive firms - especially U.S. R&D firms - devote a larger than average fraction of uses to increasing cash balances and securities holdings, reflecting the large amounts of cash raised during the stock offerings (in line with the descriptive statistics displayed in Table 3).

We also calculated various correlations of sources and uses using firm-level data averaged

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without these grants. Lach (2000) studies this issue carefully obtaining mixed results. Some of his

over time, weighted by total sources (not shown). These correlations do not control for many relevant variables, nor do they establish causality. Still, an interesting result emerges: local R&D intensive firms invest heavily in fixed capital *and* R&D. As pointed out earlier, this suggests either that R&D investment and capital expenditure are complements, or that local R&D firms "specialize" in obtaining government aid of all sorts.

Determinants of R&D intensity

We turn to the determinants of expenditure on R&D.[32] We start by asking what determines whether a firm performs R&D. From the descriptive analysis, we know that the sub-sectoral affiliation is a main determinant (over 60 percent of R&D firms are in electronics). To eliminate this dominant effect, we concentrate on firms in electronics, and on firms that issued stock in the United States (virtually all are in electronics). In the first column of Table 7 we display the results of a probit regression that uses firm-level data averaged over time where the dependent variable obtains the value 1 if a firm is a local R&D firm in electronics or a U.S. R&D firm in a given year. Only the firm's age is significant (at the 10 percent level). Curiously, the sign of the coefficient indicates that controlling for other characteristics, *older* firms are *more* likely to engage in R&D.

In the second column of Table 7, we study the determinants of the amount spent on R&D by R&D firms. We perform a panel regression using year-by-year data with both year- and firm-fixed effects. The dependent variable is R&D expenditures normalized by lagged fixed assets (property and equipment).[33] In the third column, we perform a similar regression using R&D firms in all manufacturing sub-sectors obtaining similar results. For conciseness, we will refer mainly to the results in the second column.

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results point to partial crowding out (about one half) and some to full crowding out.

[32] The 15 firms that paid royalties to the government are included in the sample from now on.

[33] Ideally, we would want to normalize by the lagged stock of R&D, but we do not have a good measure of this stock.

The descriptive statistics in Table 1 indicate that R&D firms are larger than average, and the probit regression in the first column of Table 7 indicates that R&D firms are older than average. Yet, the negative and significant coefficients on size, age, and years since going public in the regression displayed in the second column suggest that, *other things equal*, larger and older firms spend *less* on R&D *as a fraction of fixed assets*. Of course, this may be due to the fact that large and old firms are more capital intensive, so the result is merely a consequence of the normalization by fixed assets. The table also suggests that leveraged firms invest less in R&D as a fraction of fixed assets. Since leverage is more likely to finance investment in fixed assets or working capital (banks are more inclined to lend if there is collateral), also this result may be driven by the denominator of the dependent variable.

We find negative (and weakly significant) coefficients on the development area and the Tel Aviv area dummy variables. Firms located in these areas invest less in R&D as a fraction of fixed assets but, again, these results are probably driven by the normalization by fixed assets. Indeed, Blass and Yosha (2001) find that firms in development areas and in the Tel Aviv area spend significantly more than average on plants and equipment as a fraction of total uses.

The negative (and almost significant) coefficient on the U.S. R&D firm dummy variables are consistent with the finding in Table 5 that, as a fraction of total sources, U.S. R&D firms do not invest more in R&D than local R&D firms. (The negative coefficient is not likely to be driven by the normalization by fixed assets in light of the *lower* spending on physical capital by these firms; see Tables 3 and 6).

In the regression displayed in the second column, we obtain a positive (but not significant) coefficient on Tobin's q. In the third column, the coefficient on Tobin's q is both positive and significant. This suggests that - for our sample of established firms - investment in R&D behaves like investment in physical capital and responds positively to Tobin's q. (Blass and Yosha (2001) found, for a similar sample, a positive and significant relation between investment in physical capital and Tobin's q.)

The stock market performance of R&D intensive firms

To address this issue, we calculated the sales growth (that investors typically care about) of zero R&D and local R&D firms. (In what follows we omit U.S. R&D firms.) For each firm, we averaged this measure over time, and regressed it on several firm characteristics (also averaged over time), as displayed in the first column of Table 8. Not surprisingly, we find that the sales of younger firms grow faster. We also find that the sales of profitable firms grow more slowly, which is a bit surprising. Maybe profitable firms do not make as much effort to expand whereas less profitable firms do.

The coefficient on the local R&D firm dummy variable is negative and significant. That is, the sales of zero R&D firms grow faster than those of local R&D firms. The slower sales growth of the R&D intensive firms may be due to the fact that they are investing more in R&D and also in physical capital (Table 3), and their sales growth is temporarily low. Alternatively, local R&D firms may not be very "successful." In particular, it is possible that the more successful R&D firms issued stock in the US (or perhaps did not issue stock at all to avoid reporting their R&D success[34]) while the local R&D firms represent the less successful sub-sample of the R&D group. It could also be that they invest a lot in R&D and physical capital because they receive considerable R&D and capital grants from the government so that the expansion of their capital and R&D stocks is somewhat unrelated to future growth.

To further check whether local R&D firms are "successful," we study their relative stock market performance for the years 1990-1997. We calculated excess stock returns (stock returns net of the riskless interest rate) for zero R&D and local R&D firms. We averaged the excess returns over the sample length for each stock, and regressed them on time-averaged firm characteristics. The results, displayed in the second column of Table 8, indicate that the excess

[34] See Yosha (1995) for a model.

returns on the stocks of local R&D firms are slightly (but significantly) *lower* than those of zero R&D firms.

Then, we computed market "beta's" (relative to the general index of the Tel Aviv stock exchange) and risk adjusted excess stock returns adjusted for dividends.[35] We regressed the time-averaged "beta's" on time-averaged firm characteristics (see the third column of Table 8) finding an insignificant coefficient for the local R&D firms dummy. Thus, we cannot conclude that (local) R&D intensive firms are perceived by investors as more risky, which may not be surprising given their reliance on government funds. Finally, we perform a similar regression using risk ("beta") adjusted excess stock returns (see the last column of Table 8) finding a small negative but definitely insignificant coefficient on the local R&D firm dummy.

These results are not conclusive, but the following interpretation is interesting implications. Consider a *foreign* institutional investor who wants to invest in stocks traded on the Tel Aviv stock exchange. This investor is not concerned with the correlation of the returns on these stocks with the returns on the Tel Aviv stock exchange index, namely, he would not select stocks on the basis of risk ("beta") adjusted stock returns. Rather, he would invest on the basis of stock returns not adjusted for (local) market risk and, therefore, would *not* invest in the stocks of local R&D firms in light of their lower excess returns (see the second column of Table 8). By contrast, a domestic investor, who *is* concerned with the correlation of the returns on the stocks he buys with the returns on the Tel Aviv stock exchange index, is indifferent between investing in the stocks of local and zero R&D firms (see the last column of Table 8).

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[35] For each stock we computed weekly returns (out of sample) for 104 weeks in 1998 and 1999. Using these returns, weekly returns of the general index of the Tel Aviv Stock Exchange, and weekly averages of nominal money market (short-term) bank rates as a proxy for the riskless interest rate, we estimated for each stock the intercept and slope in a CAPM regression. These "beta" estimates are mostly between zero and one, but in several cases they exceed unity. In most cases, they are significantly different from zero. Using the point estimates of intercept and slope, the market returns, and the riskless rate proxy for the corresponding weeks, we constructed the expected returns for each stock according to the market model. Using the actual weekly returns of each stock in the period 1990-1997 we then computed weekly excess returns. We also computed

4. Concluding Remarks and Directions for Policy Analysis

We put to a systematic test the commonplace characterization of R&D intensive firms. This characterization probably applies to young start-ups - an issue that we did not address. Our results indicate that the characterization is only partially appropriate for established firms engaged in R&D. We found that Israeli R&D intensive firms that are traded on the Tel Aviv stock exchange ("local R&D firms") exhibit a high market to book ratio (a high Tobin's q), are younger but not faster growing than average, and do not invest primarily in intangible assets. In fact, they exhibit slower sales growth than average, and invest in physical capital more than average. Moreover, these firms do not rely more on equity financing.

Our analysis yielded several other findings. For example, many firms in our sample report having employees engaged in R&D, yet do not report R&D spending in their annual reports. We found that these firms are not engaged in research or product development but rather in activities such as quality control that should not be recorded as R&D expenses as indicated by the FASB. This suggests that government aid should be granted on the basis of R&D expenses, as is the case in practice. It also suggests that classifying firms as "R&D intensive" on the basis of the personnel they hire - a common practice in statistical bureaus - may not be ideal.

The most interesting finding, perhaps, is related to government aid for R&D. There is wide agreement that basic research should be subsidized due to the huge externalities it generates, and there is at least some agreement that some types of start-up ventures should be granted aid due to the high risk involved. (*How* this should be done is still an unsettled question.) This paper, being concerned with publicly traded firms, has nothing to say about these kinds of R&D. But, as we saw, a non-negligible share of R&D grants (34 percent on

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excess returns by subtracting the market returns from the stock returns (without controlling for risk

average) is directed to the firms in our sample which are neither start-ups and, typically, are not engaged in basic scientific research. It would be premature to draw policy conclusions from this study, but some of the findings point to potentially important aspects of R&D subsidization policy.

Our empirical findings regarding Israeli R&D intensive firms that are traded on the Tel Aviv stock exchange ("local R&D firms") suggest that these grants might not be put to their best use. First, established R&D intensive firms are more profitable than average, and may not be in great need for government funding. Second, they are often located in development areas (unlike "U.S. R&D firms") and invest a lot in physical capital. The following pattern emerges: profitable firms rely on external financing (in particular, government aid) and use these funds for investment both in physical assets and in R&D. This raises the question whether these firms need government aid for carrying out R&D. It also raises the question whether local R&D firms "specialize" in obtaining government aid. Indeed, the stock market performance of these firms is below average (according to one criterion) and their sales growth is also below average. A central policy question that arises is whether government aid for R&D is allocated to the "right" firms. We reiterate that no firm conclusions can be drawn from this study, but our findings should hopefully stimulate more research on this issue.

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in any way). We use both measures of excess returns in the analysis.

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Table 1:
Manufacturing Firms Publicly Traded on the Tel Aviv Stock Exchange and all Israeli U.S.-Listed Firms - Descriptive Statistics, 1990 - 1997
(Averages over all firms and all years;* standard deviation in parentheses)

	Zero R&D Firms	Local R&D Firms	U.S. R&D Firms
Size (total assets – Dec 1998 million NIS)	217 (423)	479 (1423)	459 (635)
Firm Age (years since incorporation)	29 (16.8)	20.2 (13.8)	10.7 (7.5)
Years Since Going Public	6.9 (7.7)	7.0 (8.7)	4.2 (5.7)
Profitability (net profits / sales)	0.040 (0.002)	0.055 (0.08)	0.092 (0.016)
Return on Equity (net profits / equity)	0.094 (0.006)	0.091 (0.007)	0.127 (0.021)
Leverage (total assets minus equity / total assets)	0.524 (0.006)	0.567 (0.012)	0.415 (0.025)
Percentage of Firms in Development Areas	0.178	0.273	0.086
Sales Growth	0.109 (0.249)	0.180 (0.338)	0.555 (0.629)
Number of Firm-Years	1050	275	152

*"Profitability" is weighted by sales, "Return to Equity" by equity, "'Leverage" by total assets, and "Sales Growth" by sales.

Table 2:
Flow of Funds in Manufacturing Firms Publicly Traded on the Tel Aviv Stock Exchange and in all Israeli U.S.-Listed Firms - Average Sources , 1990 - 1997
(Averages over all firms and all years weighted by total sources; December 1998 million NIS; fraction of total in space brackets; standard deviation in parentheses)

	Zero R&D Firm	Local R&D Firms	U.S. R&D Firms
Internally Generated Cash	18.1 [0.596] (39.9)	42.2 [0.435] (131.2)	66.8 [0.469] (115.3)
Net Stock Issues	7.1 [0.233] (21.4)	11.9 [0.123] (35.1)	46.9 [0.329] (84.7)
Net Increase in Debt[1]	3.8 [0.124] (39.7)	26.6 [0.274] (220.1)	18.7 [0.131] (103.3)
Net Government Aid[2]	1.4 [0.046] (5.9)	16.3 [0.168] (69.0)	10.2 [0.072] (18.4)
Total Sources	30.4 (68.3)	96.9 (376.5)	142.4 (192.5)
Number of Firm-Years	1050	275	152

1)Bonds and bank debt.

2)Includes grants, R&D subsidies net of royalties, and deferred taxes.

Table 3:
Flow of Funds in Manufacturing Firms Publicly Traded on the Tel Aviv Stock Exchange and in all Israeli U.S.-Listed Firms - Average Uses, 1990 - 1997
(Averages over all firms and all years weighted by total sources; December 1998 million NIS; fraction of total in space brackets; standard deviation in parentheses)

	Zero R&D firms	**Local R&D firms**	**U.S. R&D firms**
Capital Expenditure	16.7 [0.547] (41.5)	57.4 [0.591] (242.3)	24.7 [0.174] (49.8)
Investment in Inventory	2.7 [0.088] (16.7)	3.8 [0.039] (26.5)	8.9 [0.062] (38.4)
Investment in Working Capital	3.3 [0.108) (20.8)	0.9 [0.010] (44.9)	8.5 [0.060] (33.2)
Investment in Cash and Securities	3.6 [0.117] (30.1)	15.5 [0.150] (163.7)	55.1 [0.394] (176.2)
Dividends	4.2 [0.138] (14.1)	8.0 [0.081] (29.9)	3.9 [0.027] (27.5)
R&D Expenditure (gross)	0.00 [0.00] (22.4)	12.4 [0.128] (125.1)	40.0 [0.281] (133.1)
Total Uses	30.4 (68.3)	96.9 (376.5)	142.4 (192.5)
Number of Firm-Years	1050	275	152

Table 4:
Tobin's q for Manufacturing Firms Publicly Traded on the Tel Aviv Stock Exchange and all Israeli U.S.-Listed Firms, 1990 - 1997
(December 1998 million NIS; unweighted averages over all firms; standard deviation in parentheses; number of observations)

	Average: year ending 1990	**Average: year ending 1991**	**Average: year ending 1992**	**Average: year ending 1993**	**Average: year ending 1994**	**Average: year ending 1995**	**Average: year ending 1996**	**Average: year ending 1997**	**Average: all firms and all years**
Zero R&D Firms	1.04 (0.24) 66	1.23 (0.37) 103	1.73 (0.66) 123	2.21 (0.96) 138	1.16 (0.38) 153	1.05 (0.37) 158	0.91 (0.24) 139	0.97 (0.33) 134	1.27 (0.67) 1014
Local R&D Firms	0.97 (0.24) 15	1.51 (0.93) 28	2.29 (1.22) 39	2.62 (1.34) 34	1.05 (0.27) 34	1.07 (0.44) 41	1.10 (0.69) 37	1.25 (0.60) 38	1.48 (0.99) 266
U.S. R&D Firms	1.82 (1.08) 3	7.19 (6.36) 7	4.06 (1.19) 8	3.19 (1.28) 14	2.20 (1.92) 20	2.61 (1.46) 29	1.64 (1.19) 27	1.92 (1.51) 19	2.53 (2.11) 127

Table 5:
Factors Affecting Flow of Funds in Manufacturing Firms Pu
blicly Traded on the Tel Aviv Stock Exchange and all Israeli U.S.-Listed Firms - Sources, 1990 - 1997*

(GLS regressions using firm-level data averaged over time; t-statistics in parentheses)

	Internally Generated Cash**	Net Stock Issues	Net Increase in Debt	Government Aid***
Size (log-total assets)	0.036 (0.879)	-0.033 (-2.905)	0.012 (0.334)	-0.017 (-1.274)
Profitability (net profits / sales)	0.013 (0.052)	-0.505 (-7.353)	0.230 (1.008)	0.262 (3.269)
Return on Equity (net profits / equity)	0.065 (0.553)	0.038 (1.219)	-0.129 (-1.241)	0.026 (0.719)
Industry Dummies	YES	YES	YES	YES
Greater Tel Aviv Area Dummy[a]	0.315 (2.337)	-0.141 (-3.908)	-0.051 (-0.422)	-0.123 (-2.921)
Development Area Dummy[b]	0.085 (0.558)	-0.002 (0.043)	-0.162 (-1.196)	0.079 (1.653)
Multi-Plant Firm Dummy[c]	0.162 (1.076)	-0.088 (-2.174)	-0.053 (-0.379)	-0.021 (-0.447)
Firm Age (years since incorporation)	0.007 (1.667)	-0.001 (-1.031)	-0.006 (-1.564)	0.000 (-0.009)
Years Since Going Public	0.357 (1.556)	-0.106 (-1.726)	-0.211 (-1.033)	-0.039 (-0.557)
U.S. R&D Firm Dummy	-0.206 (-1.283)	0.083 (1.929)	0.039 (0.279)	0.082 (1.658)
Local R&D Firm Dummy	-0.084 (-0.596)	-0.048 (-1.257)	0.023 (0.187)	0.107 (2.455)
R-Squared	0.145	0.484	0.117	0.229

* Regressions are weighted by total sources. Number of observations: 248. Zero R&D firms are the control group.

** Internally generated cash and R&D expenses.

***Includes grants, R&D subsidies, and deferred taxes.

a) Equals 1 if firm is located in area codes 03, 09, and 0 otherwise.

b) Equals 1 if firm is located in area codes 06, 07, and 0 otherwise.

c) Equals 1 if firm has plants in more than one region, and 0 otherwise. Area codes 02, 04, 08 are the control region.

Table 6:
Factors Affecting Flow of Funds in Manufacturing Firms
Publicly Traded on the Tel Aviv Stock Exchange and all Israeli U.S.-Listed Firms - Uses, 1990 - 1997*

(GLS regressions of ratio to total uses using firm level data averaged over time; t-statistics in parentheses)

	Capital Expenditure	Investment in Inventory	Investment in Working Capital	Investment in Cash and Securities	R&D Expenditure (gross)**	Dividends
Size (log-total assets)	-0.023 (-0.909)	-0.039 (-1.573)	0.053 (1.899)	0.011 (0.260)	-0.019 (-0.239)	0.004 (0.388)
Profitability (operating profits / sales)	0.378 (2.402)	-0.172 (-1.107)	-0.088 (-0.514)	-0.442 (-1.644)	0.524 (1.564)	-0.001 (-0.008)
Return on Equity (net profits/ equity)	-0.118 (-1.645)	-0.001 (-0.017)	0.064 (0.804)	0.037 (0.304)	0.011 (0.061)	0.003 (0.088)
Industry Dummies	YES	YES	YES	YES	NO	YES
Greater Tel Aviv Area Dummy[a]	-0.072 (-0.871)	-0.066 (-0.810)	0.211 (2.329)	0.225 (1.593)	-0.499 (-2.299)	-0.027 (-0.743)
Development Area Dummy[b]	0.273 (2.906)	0.132 (1.435)	-0.124 (-1.206)	-0.129 (-0.803)	-0.440 (-1.728)	0.002 (0.041)
Multi-Plant Firm Dummy[c]	0.019 (0.215)	0.062 (0.648)	-0.023 (-0.227)	0.051 (0.326)	-0.228 (-0.789)	-0.044 (1.070)
Firm Age (years since incorporation)	0.001 (0.499)	-0.005 (-2.052)	-0.002 (-0.594)	0.004 (1.059)	-0.001 (-0.138)	0.002 (1.533)
Years Since Going Public	-0.064 (-0.458)	-0.229 (-1.634)	-0.032 (-0.213)	0.508 (2.119)	-0.046 (-0.115)	-0.083 (-1.340)
US R&D Firm Dummy	-0.115 (-1.175)	-0.144 (-1.489)	-0.227 (-2.108)	0.467 (2.789)	-0.071 (-0.322)	-0.066 (-1.507)
Local R&D Firm Dummy	0.120 (1.390)	-0.112 (-1.312)	-0.198 (-2.098)	0.165 (1.125)		-0.058 (1.533)
R-Squared	0.285	0.062	0.112	0.118	0.138	0.155

* Regressions are weighted by total sources. Number of observations: 248. Zero R&D firms are the control group.

** In this regression, only U.S. and local R&D firms were used (65 observations). For this reason, most dummy variables were omitted.

a) Equals 1 if firm is located in area codes 03, 09, and 0 otherwise.

b) Equals 1 if firm is located in area codes 06, 07, and 0 otherwise.

c) Equals 1 if firm has plants in more than one region, and 0 otherwise. Area codes 02, 04, 08 are the control region.

Table 7:
Factors Affecting Year-by-Year R&D Expenditure Manufacturing Firms Publicly Traded on the Tel Aviv Stock Exchange and all Israeli U.S.-Listed Firms, 1990 – 1997*

	Firms in Electronics**	R&D Firms in Electronics**	All R&D Firms
	Probit regression Dependent variable=1 for R&D firms	GLS regression* Dependent variable : R&D expenditure / lagged property and equipment	GLS regression* Dependent variable : R&D expenditure / lagged property and equipment
Size (log-total assets)	-0.135	-0.376 (-4.777)	-0.339 (-5.188)
La/gged q	-0.691	0.051 (1.335)	0.066 (2.122)
Leverage (total assets minus equity / total assets)	0.019	-0.227 (-1.302)	-0.223 (-1.508)
Industry Dummies	NO	NO	YES
Year Dummies	YES	YES	YES
Greater Tel Aviv Area Dummy[a]	-0.108	-0.174 (-1.632)	-0.089 (-1.042)
Development Area Dummy[b]	0.383	-0.284 (-1.805)	-0.133 (-1.309)
Multi-Plant Firm Dummy[c]	0.114	0.303 (1.151)	0.150 (1.003)
Firm Age (years since incorporation)	0.029++	-0.011 (-2.061)	-0.008 (-2.103)
Years Since Going Public	-1.947	-0.454 (-1.760)	-0.434 (-1.938)
US R&D Firm Dummy	-6.140	-0.149 (-1.556)	-0.124 (-1.595)
R-Squared****	-	0.258	0.212
Number of observations	265	189	265***

*The regression in the first column uses time-averaged data. The regressions in the second and third columns use year-by-year data and include year- and firm-fixed effects and are weighted by total sources. t-statistics in parentheses.
**Includes all firms traded in the U.S. (most are in electronics)
***Accidentally, the number of observations is the same that as in the first column.
**** R-squared of the weighted regression.
+ Significant at the 10 percent level.
++ Significant at the 5 percent level.
a) A dummy variable that equals 1 if firm is located in area codes 03, 09, and 0 otherwise.
b) A dummy variable that equals 1 if firm is located in area codes 06, 07, and 0 otherwise.
c) A dummy variable that equals 1 if firm has plants in more than one region, and 0 otherwise. Area codes 02, 04, 08 are the control region.

Table 8:
Factors Affecting Market Betas and Excess Stock Returns of Zero R&D versus Local R&D Firms 1990 - 1997*

(GLS regressions using firm-level data averaged over time; t-statistics in parentheses)

	Sales Growth**	Excess Returns Not Adjusted for Risk	Beta	Risk Adjusted Excess Returns
Size (log-total assets)	-0.006 (-0.421)	0.002 (3.500)	0.081 (3.527)	0.002 (2.725)
Profitability (net profits / sales)	-0.467 (-5.125)	0.004 (0.837)	0.229 (1.209)	0.004 (0.610)
Return on Equity (net profits / equity)	0.033 (0.792)	0.002 (0.962)	-0.046 (-0.645)	0.001 (0.509)
Industry Dummies	YES	YES	YES	YES
Greater Tel Aviv Area Dummy[a]	0.059 (1.207)	-0.007 (-3.035)	0.029 (0.333)	-0.008 (-2.747)
Development Area Dummy[b]	-0.026 (-0.478)	-0.009 (-4.017)	0.113 (1.362)	-0.007 (-2.314)
Multi-Plant Firm Dummy[c]	-0.043 (-0.785)	-0.008 (-3.431)	0.008 (0.094)	-0.008 (-2.799)
Firm Age (years since incorporation)	-0.006 (-3.770)	-0.0001 (-2.098)	-0.0003 (-0.173)	-0.0002 (-3.132)
Years Since Going Public	0.123 (1.208)	0.013 (3.500)	-0.058 (-0.416)	0.012 (2.464)
Local R&D Firm Dummy	-0.108 (-2.208)	-0.004 (-1.961)	-0.059 (-0.840)	-0.001 (-0.433)
R-Squared	0.425	0.379	0.354	0.352
Number of Observations	244	183	177	176

* The U.S. R&D firms are not included in the regressions. Weekly returns averaged over the sample period. Regressions are weighted by total sources.

** Sales growth is calculated starting from the IPO year.

a) Equals 1 if firm is located in area codes 03, 09, and 0 otherwise.

b) Equals 1 if firm is located in area codes 06, 07, and 0 otherwise.

c) Equals 1 if firm has plants in more than one region, and 0 otherwise. Area codes 02, 04, 08 are the control region.