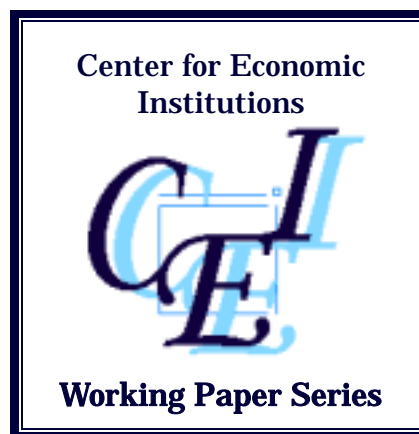


Center for Economic Institutions
Working Paper Series

CEI Working Paper Series, No. 2001-24

*Sources of Funds and Investment Strategies of
Venture Capital Funds: Evidence from Germany,
Israel, Japan and the UK*

Colin Mayer
Koen Schoors
Yishay Yafeh



Institute of Economic Research
Hitotsubashi University
2-1 Naka, Kunitachi, Tokyo, 186-8603 JAPAN
Tel: +81-42-580-8405
Fax: +81-42-580-8333
e-mail: cei-info@ier.hit-u.ac.jp

Sources of Funds and Investment Strategies of Venture Capital Funds:
Evidence from Germany, Israel, Japan and the UK

Colin Mayer

Koen Schoors

Yishay Yafeh

This paper was presented at the conference on *Designing Financial Systems in East Asia and Japan: Toward a Twenty-First Century Paradigm*. This two-day conference was co-organized by the International Monetary Fund and the CEI. It was held during September 24-25, 2001 at Hitotsubashi Memorial Hall in Tokyo, Japan. A select group of academics, researchers and policy makers from around the world gathered to examine the timely issue of how the financial systems and corporate governance in East Asia and Japan should be redesigned in order to achieve sustainable economic development. The conference included six sessions with 17 papers. All the presented papers were added to the CEI series of working papers. The series, as well as the contents of the conference, can be reached at <http://cei.ier.hit-u.ac.jp>.

**Sources of Funds and Investment Strategies of Venture Capital Funds:
Evidence from Germany, Israel, Japan and the UK**

Colin Mayer

Saïd Business School, University of Oxford and CEPR
colin.mayer@sbs.ox.ac.uk

Koen Schoors

University of Ghent and Saïd Business School, University of Oxford
koen.schoors@sbs.ox.ac.uk

Yishay Yafeh

Hebrew University of Jerusalem and St Antony's College, Oxford
yishay.yafeh@sant.ox.ac.uk

Preliminary Draft

9 July 2001

We gratefully acknowledge financial support from the European Commission Research Training Network "Understanding Financial Architecture: Legal and Political Frameworks and Economic Efficiency". This paper was written while Yishay Yafeh was a visiting fellow at St. Antony's College and the Nissan Institute, University of Oxford whose hospitality and financial support are gratefully acknowledged.

Abstract

Using a newly constructed data set, we compare sources of funds and investment strategies of venture capital (VC) funds in Germany, Israel, Japan and the UK. Sources of VC funds differ significantly across countries, e.g. banks are particularly important in Germany, corporations in Israel, insurance companies in Japan, and pension funds in the UK. VC investment patterns also differ across countries in terms of the stage and sector of financed companies, as well as in the geographical focus of investments, and these differences are significantly related to the variations in funding sources. However, the influence of particular classes of institutions differs across countries. For example, bank backed VC firms in Germany and Japan are as involved in early stage finance as other funds in these countries, whereas in Israel and the UK they tend to invest in relatively late stage finance. While these financial institutional factors account for some of the differences in investment patterns across countries, other considerations (such as supply of entrepreneurs) are of greater significance.

Key words: Venture capital, financial institutions, sources of funds

JEL classification: G20, O32.

1. Introduction

Promotion of entrepreneurship and innovation has become one of the primary industrial policies of developed economies around the world. For example, at the Nice European Council of December 2000, the leaders of the 15 member states of the European Union described entrepreneurship as a central component of European employment policy. The development of a venture capital (VC) industry is often regarded as a primary part of this policy.

The question that this raises is how can VC be promoted. Some see the supply of entrepreneurs, the science base, technical transfer from universities to industry, and the ability of entrepreneurs to capture the fruits of their inventiveness as the keys to investment in technology related industries. Others regard the financial system and the supply of risk capital as critical factors. Policies to encourage investors to invest in private equity and to encourage institutions to be less risk averse in their investment strategy have supply of funds at their root. For example, Gompers and Lerner (1998) argue that relaxation of the “prudent man” rule in the US at the end of the 1970’s allowed the rapid growth of VC to occur in the 1990’s.

The relevance of financial institutions and financial systems to corporate activity has been much discussed in the academic literature. Black and Gilson (1998), for example, contrast bank and stock market-oriented financial systems, and argue that initial public offerings (IPOs) provide an important exit route for VC funds. More generally, differences in financial systems have been associated with different types of investments. Allen (1993) and Allen and Gale (1999) have argued that stock markets allow investors to hold diverse views about investments, whereas banks are well equipped to acquire information about firms where there is a high degree of consensus. Securities markets are therefore particularly relevant where investors have

diverse views about, for example, new technologies, whereas banks can exploit economies of scale in collecting information about more traditional investments in, for example, manufacturing. Carlin and Mayer (1999) report a relation between the types of activities undertaken in different countries and the structure of countries' financial systems.

This paper focuses exclusively on VC activities and poses the question how does the structure of VC funds and, in particular, their financing, affect their activities. We report results from a newly constructed database consisting of about 500 venture capital firms in four countries – Germany, Israel, Japan and the UK. The database is valuable not only for studying the venture capital industry but also as a source of information on the above debates on relations between sources of finance and investment activity more generally. The data provide quite unique insights on both the types of investments made by financial institutions by stage of activity, sector and location and on the sources from which they raise their finance. It is therefore possible to undertake new analyses of how financing relates to institutions' investment allocations and to undertake comparisons of this across countries.

As regards the analysis of the VC industry itself, it differs from the existing literature in several respects. Firstly, the existing literature is almost exclusively focused on the US. For example, a large number of studies by Gompers and Lerner (1999) consider several financial aspects of VC investments and their impact on financial aspects of the performance of VC backed firms (e.g. at the time of the IPO). Hellman and Puri (2000) study the influence of VC funds on the activities of their clients, and Kaplan and Stromberg (2000) examine the contractual relations between the funds and their clients.

VC activity is growing rapidly elsewhere and there is increasing interest in the performance of the VC industry outside of the US.¹ This paper considers four countries - Germany, Japan, Israel and the UK, all of which have significant and/or rapidly growing VC industries. The spread of countries is interesting because it includes two bank-oriented systems (Germany and Japan), one (non-US) market-oriented system and one major high technology success story, Israel, with supposedly the largest concentration of VC investments outside of California and Massachusetts. Within Europe, Germany and the UK are particularly important for the study of the VC industry, because these two countries together account for over half of all VC investments in the Continent (BVK, 2000).

Secondly, most analyses of VC in different countries report aggregate statistics. In this paper we employ disaggregated data at the individual fund level. Thirdly, to the extent that disaggregated data have been used they have focused on firms. We focus on the VC funds themselves rather than firms. The question that we pose is to what extent can differences in VC activities (in particular, stage of finance and sector focus) be associated with their sources of finance. Do VC firms that are funded through banks invest in firms at different stages of their development from those that are funded by private individuals? Do pension and insurance fund backed VC firms have a different sector focus from corporate backed funds? To the best of our knowledge, no study has yet examined the relation between sources of funds and investment strategies in the VC industry.

We take two different approaches to answering this question. The first assumes homogeneity of particular classes of investors across countries, i.e. that banks in the UK are equivalent to banks in Germany and that, insurance companies in

¹ See a survey of VC activity in Europe in Botazzi and Da Rin (2001).

Israel are equivalent to insurance companies in Japan. The second approach examines whether similar institutions behave differently in different countries. This answers the question whether banks in Germany have a different investment strategy from those in the UK. In both cases we control for other cross-country factors, i.e. other institutional and demand for funds considerations, and focus on the influence of sources of finance.

The results are striking. Firstly, there are substantial differences across countries in terms of the stage of finance of VC firms. They are much more focused on early stage investments in some countries, most notably Israel, than others, in particular Japan. There is a remarkably close similarity in stage of finance between Germany and the UK despite the frequently cited differences in their financial systems. Secondly, there are significant differences in VC's sector focus. While biotechnology and life sciences receive a substantial level of attention in all four countries, a much larger fraction of VC firms in Israel and Japan invest in information technology (IT) and software than in Germany and the UK, where the manufacturing sector receives more attention. Investment in electronics appears to be relatively uncommon in Japan.

Turning to institutional differences across countries, we find that there are substantial variations in the sources of finance of VC firms. Banks are a major source of external finance in all countries, particularly in Germany and Japan. Pension funds are much more significant in the UK than in the other three countries. Corporations are a more important source of finance of VC firms in Israel than elsewhere.

We find that there are significant relations between sources of finance of VC firms and their investment activities within countries. In particular, banks and pension funds backed VC firms invest in later stage and VC firms relying on private

individual investors favour earlier stage activities. Industry and privately backed funds are focused towards IT, software and electronics and away from manufacturing sectors, while the reverse holds for pension funds. However, we also find that there are significant differences in the relation between financing and investment stage in different countries. While bank backed VC firms in Israel and the UK invest in later stage activities relative to other sources of finance, bank backed funds in Germany and Japan are no different from other VC funds. Later stage investing by pension funds is a feature of the UK but not of Israel, the only other country where pension funds is a significant source of VC finance.² Institutional variations are therefore associated with significant differences in the investment patterns of VC firms within countries.

A key question is the extent to which they also account for international differences. This is not entirely straightforward to answer because the investment activity of similar institutions differs across countries. However, it is clear that a substantial proportion of international differences in investment patterns is associated with factors other than sources of financing. Some of this may be attributable to unobserved institutional factors (e.g. whether funds are independent or captive), but most is probably associated with demand side considerations, such as the supply of entrepreneurs and the structure of countries' technology sectors. The paper therefore points to institutional differences as being one but not the dominant influence on international differences in the investment activity of VC firms.

The paper is organized as follows. In the next section, we present a conceptual framework for our empirical analysis. Our database is described in

² The few pension funds investing in Israel are American.

Section 3. Section 4 presents the empirical findings from the regression analyses and Section 5 concludes the paper.

2. Conceptual Framework

The allocation of money by VC fund i to investment activity j is α_{ij} , a function of the return that fund i anticipates earning on activity j , E_iR_j and i 's risk preferences σ_i

$$\alpha_{ij}(E_iR_j, \sigma_i) \quad (1)$$

A VC fund raises capital from a variety of different sources, s , ($s = 1$ to S). Investors in the VC fund have preferences between different types of investments reflecting their risk preference, their time horizons and their own asset/liability structure. The risk preference of fund i is assumed to reflect that of its investors, and each class of investors is assumed to have a particular risk preference. σ_i is therefore a function of β_{is} , the share of fund i 's finance from investor s . We write α_{ij} in a linear form:

$$\alpha_{ij} = a_0 + a_1E_iR_j + \sum_s a_s \beta_{is} \quad (2)$$

E_iR_j will be a function of, *inter alia*, the supply of entrepreneurs available to undertake activity j , the infrastructure available to support activity j (for example, the knowledge base in universities), and the demand for the products and services generated from activity j (for example, the technological requirements of business and government). We assume that these determinants of E_iR_j are the same for all VC funds operating in a particular economy but that they differ across k economies (i.e. R_{jk}). All VC funds in a particular economy therefore face the same demand functions, and allocations between different activities are purely determined by the preference functions of the suppliers of capital. Thus for fund i operating in country k

$$\alpha_{ij} = a_0 + a_k + \sum_s a_s \beta_{is} \quad (3)$$

Figure 1 shows supply of VC funds against returns (R_{jk}) for activity j from two funds ($i = 1$ and 2) that obtain their finance from different sources. This is shown for two countries ($k = A$ and B) with different demand for funds from entrepreneurs (D_{jk}) but with the same supply schedules (S_{ij}) reflecting the fact that the VC's obtain their funds from the same sources in the two countries. The assumption of funds facing common demands from entrepreneurs within a country but not across countries allows the identification of the supply schedule.

Equation (3) assumes that similar institutions in different countries have identical preference functions. However, the nature and structure of equivalent institutions may differ appreciably across countries. For example, commercial banks in Germany and Japan are frequently viewed as establishing closer and longer-term relations with companies than banks in the UK. Similarly, while in the UK investment management firms are often independent, in Germany they tend to be subsidiaries of banks and other financial institutions. These differences may influence the preferred investment activities of equivalent institutions in different countries. Equation (4) takes account of this by allowing the relation between VC fund activity and sources of finance to vary across countries.

$$\alpha_{ijk} = a_0 + a_k + \sum_s a_{ks} \beta_{is} \quad (4)$$

Figure 2 shows this for two VC funds that, as in Figure 1, derive their finance from different sources in each country and the same sources in the two countries but now the relation between activity and source of finance is allowed to differ across the countries.

In the subsequent analysis, we will estimate the coefficients a_s and a_{ks} that relate the sources of finance of VC firms to the allocation of their investments, α_{ij} .

3. Data

3.1 Sources and Sample Coverage

Our data are drawn from the individual countries' venture capital associations. For Germany and the UK, we use information from the European association of venture capitalists (evca.com) as well as from their respective local associations, reflecting the latest available figures (probably 2000). For Israel, we use data provided by the Israeli association of venture capital (ivc-online.com), and for Japan we rely on a survey conducted by *Nikkei Kinyu* (Financial Nikkei) in 1999 on venture capital activities in Japan.

For Germany, Israel and the UK we have data on all VC funds included in the associations, although some funds do not fully disclose data on their sources of funds and investment activities. Our database includes 187 German funds, 119 from Israel and 140 from the UK.³ For Japan, the survey we use includes information on 62 VC funds, about half of the extant population of VC funds in Japan according to this survey. We have no reason to suspect any particular bias in this sample of respondents.⁴

For each venture capital fund we collect information on the fund size (capitalization) (section 3.2), its corporate form and types of investment (section 3.3), its sources of funds or ownership (section 3.4), and its investment strategies by stage of investment (section 3.5), sector (section 3.6) and location of investment (section 3.7).

3.2 Size of Funds

³ Membership of a particular country's VC association is open to funds operating in that country irrespective of where the fund is owned or controlled.

Measuring fund size in terms of assets under management, British venture capital funds are by far the largest, with mean capital of over 900 million US dollars, about six times bigger than the average Japanese fund (\$115m), and twelve times bigger than the average Israeli fund (\$73m). Although no information on individual fund size is available for Germany, aggregate statistics suggest that the average German fund is about the same size as the average Israeli fund, with capital of about \$77m (BVK, 2000). Using medians rather than means suggests that in all countries the majority of funds are much smaller. In the UK the median VC has capital of about \$140m, compared with only \$12m in Japan and about \$40m in Israel. Interestingly, the median Israeli fund is bigger than the median Japanese fund, although both are much smaller than the median British VC.

3.3 Corporate Form and Types of Investment

VC firms have different legal structures in the four countries of our sample. In the Japanese sample, all VC funds are joint stock companies. In Germany about a quarter of the funds are listed companies (AG's), and in the UK limited partnership is the most common form of VC organization (only about 5 percent of the funds are public companies).

Data on types of investment made by funds are available for Germany and Israel. In both countries, equity is the dominant form of investment. Loans are provided by about one-sixth of funds in Germany, and in Israel convertible debt (but not straight debt) is provided by about half of funds.

⁴ A more recent survey conducted by Nikkei Venture Business (2001) provides a larger sample of about 100 VC funds and other providers of finance, but with only limited information on their

3.4 Sources of Finance

As noted, all venture capital funds in our Japanese sample are joint stock companies, and their owners are also their investors and providers of funds. In other countries, funds report whether they received finance from a certain category of investor. We define a number of (not mutually exclusive) dummy variables that equal one if the fund reports having used this source of finance. These dummies signify whether there is bank finance (BANK), finance from pension funds (PENSION), insurance companies (INSUR), other financial institutions (OTHER), corporate investors (CORPORATE), private individual investors (INDIVIDUAL) or the government and regional authorities (GOV). We also identify funds that rely exclusively on bank finance or, for Japan, funds that are at least 50 percent bank-owned.

Table 1 displays the sources of external finance for the VC industry in the four countries.⁵ There are clearly some important differences between the countries. In Germany, banks are by far the most important source of finance for the VC industry, nearly twice as popular as the second largest source of finance, individual investors. Bank finance is between three and four times more popular in Germany than finance from industrial corporations or insurance companies. Relying exclusively on bank finance is also very common in Germany: two thirds of the VC funds that raise money from banks use this source exclusively. The equivalent figure for Japan is about one half, for the UK one third, and only about one fifth for Israel.

activities.

⁵ In the UK sample, there are 19 funds that rely exclusively on their own or their parent company funds.

Pension funds are conspicuously absent as a source of venture capital funds in Germany.⁶ This is in sharp contrast to the UK where pension funds, other institutional investors, and individual investors provide funds to as many companies as banks. Government (typically local authorities) funding plays a more important role in the UK than it does in Germany, and is negligible in the other countries.

Sources of funds for the Israeli VC industry are widespread, with industrial corporations (typically from the US) being the single most popular source of funds. Since Japanese funds are organized in the form of joint stock companies (rather than as limited partnerships) with the owners providing the sources of funds, the figures for Japan in Table 1 are based on detailed fund ownership data. Non-bank financial institutions (e.g. credit card or leasing companies and mortgage institutions) are the single most important category of finance among Japanese funds, followed by banks and insurance companies. It is quite common in Japan for the owners/providers of finance for Japanese VC funds to be all affiliated with the same bank-centered corporate group, or to be otherwise related to each other. In over half of the Japanese funds in our sample, at least three of the five largest shareholders-providers of finance are related to each other or affiliated with the same group.

It is interesting to note from Panel B of Table 1 that VC funds in Germany tend on average to use fewer sources of funds than do VC's in other countries, and 61 percent of them rely on a single source of funds. By contrast, funds in Israel, Japan and the UK tend to use many sources of finance; in particular, about a quarter of the British funds report using at least four different sources.

⁶ In the German data, up to 1999, pension fund contributions to VC funding have been small (BVK, 2000) and are included in the category "other financial institutions." BVK (2000) suggests that in recent months, as a result of on-going reforms in the German pension system, pension funds have become a much more important source of funds for the VC industry. Differences between Germany and the UK in this respect may therefore diminish over the next few years.

For the UK and Germany, it is possible to compare the figures in Table 1 with aggregate statistics on sources of VC investment (BVK, 2000). The aggregate figures differ somewhat from the figures in Table 1, because they are based on the amounts invested rather on whether or not a particular source is used. Nevertheless, aggregate figures support our conclusions that banks are by far the most important source of finance for the German VC industry, whereas in the UK pension funds, banks and insurance companies are the largest sources.⁷

3.5 Type of Investment Activity: Investment Stage

To what extent do these striking differences in sources of finance for VC funds affect the nature of their investments? Table 2 provides statistics on the type of investment activity funded by VC's in the four countries, characterizing investments by the technological stage at which they are made, industry preferences and geographical focus. Panel A displays the percentage of VC funds investing in different stages and their average stage of investment. Funds typically report focus on one or more categories of investments (seed, start-up, middle, expansion and growth, later stages including refinancing and management buy-ins and buy-outs (MBI/MBOs)). Assuming equal investments in all categories in which the fund reports positive investment, we assign the value 1 to early stage investments (seed and start-up), the value 2 to middle, expansion and growth investments, and the value 3 to later stage investments.⁸ We then calculate an "average stage" for each fund's positive investments, which ranges in value between 1 and 3.

⁷ The significance of individual investors as a source of funds is greater in our data than in the aggregate figures, probably because they provide small amounts of money relative to other, institutional, sources of funds.

⁸ In the Japanese data, the definition of the stages is somewhat different, but the three categories in the survey correspond to early, middle and later stages.

Panel A of Table 2 shows that the VC industry in Israel provides finance primarily to companies in early stages of development. Nearly all funds report positive investments in firms in their early stages. The average stage of investment is 1.4, between “early” and “middle” stages. VC funds in Germany and the UK provide funding to companies in all stages, with a slight bias towards later stages of development (their average investment stage is about 2 or “middle,” with the figure for the UK somewhat higher than that of Germany). In Japan, VC funds are predominantly directed at companies in later stages of development with very little support for seed and start-up companies. Average stages of financing in Germany, Israel and Japan are all statistically different from those in the UK. The distributions of fund investments by stages are also statistically different at the 5 percent level in Israel and Japan from the UK. The proportion of funds investing in early stages is significantly higher (at the 5 percent level) in Germany than in the UK.

These observations are consistent with evidence from other sources. EVCA (2000) reports that the distribution of investments for UK funds is centered around firms in middle stages of development, when measured by the number of companies in which investments are made.⁹ Jeng and Wells (2000) report that investment in early stages relative to GDP has been slightly higher in Germany than in the UK in recent years, although in the past the UK has invested relatively more in companies in their early stages. BVK (2000) provides figures that are consistent with these observations as well. IVA (2000) confirm our observation that VC investments in Israel are focused on early stages.

3.6 Type of Investment Activity: Sector

⁹ In terms of *amounts* invested, there seems to be more weight on later stage investments involving MBI/MBO activities.

VC funds record the industries in which they invest and we classify funds' investments into one or more of the following five categories of industries: (1) life sciences, biotechnology and environmental technology; (2) software, communication and information technology; (3) electronics and semiconductors; (4) manufacturing (including chemicals); (5) services and other sectors. Again, we only have information on whether or not a fund invests in a particular sector and do not know the exact amounts. In what follows, the industry shares are constructed under the assumption of equal investments in all the industries in which a fund invests positive amounts. Thus, if a fund invests in n industries, each industry's share in total investment is assumed to be $1/n$.

Panel B of Table 2 report the industry distribution of VC investments in the three countries. There are substantial differences. VC funds in Israel and Japan invest predominantly in the IT and software industry, whereas the distribution of investments across industries in Germany and the UK is more even, and surprisingly similar to each other. Another surprising result is that in Japan, the electronics industry seems to be a less favourable target for VC investments than it is in other countries. Manufacturing and chemicals are relatively more popular in Germany and the UK.

Panel C of Table 3 reports the number of industries in which VC funds on average invest in the four countries. Funds are heavily diversified across sectors (four or more) in the UK and Germany, and somewhat less so in Japan. In Israel, many more funds are concentrated in only one sector.

Again, the available aggregate statistics are not easily comparable because the industry classifications used differ between sources. Nevertheless, for Israel, IVA (2000) provide figures on VC investments by industry, which are consistent with ours.

For Germany and the UK, BVK (2000) confirms the relative even spread of investments across sectors, with IT and manufacturing being important investment targets.

3.7 Type of Investment Activity: Location

Finally, we gather information on the geographical concentration of fund investments in specific regions or countries. We describe each fund's geographical focus as follows: we assign the number 1 to it if it invests within a single region within a country; 2, if it invests anywhere in its domestic country; 3 if it operates within a single continent; 4, if it operates worldwide (i.e. in two or more continents). Since Japanese companies report the fraction of their investments invested abroad (with no geographical breakdown), we construct the variable for Japan in a slightly different way. We assign the number 1 to it if the fund is regional; 2 if it invests in Japan only; 3 if it invests up to 50 percent of its funds abroad; and 4 if over 50 percent of the fund's investment are abroad.

There are again some interesting differences across countries (Panel D of Table 2). The UK venture capital industry is the most international with 60 percent of funds having some investments outside the UK. By contrast, two thirds of German funds invest only in Germany (or in a region within Germany). Aggregate statistics from BVK record that UK VC funds invest 25 percent of their capital abroad, compared with 15 percent invested outside Germany by German VC firms.

4. The Determinants of VC Investments

To what extent are the differences in investment activity driven by the preferences of the different institutions supplying capital to the VC industry? Is it the

case, for example, that bank finance, which is common in Japan, is an important reason for this country’s preference for later stage investments? Alternatively, are activities driven by the “pool” of entrepreneurs in each country and the nature of the activities for which they seek funding?

The fact that the German VC industry supports earlier stage companies than the Japanese might suggest at first sight that bank finance is not the main reason for Japanese “conservatism”. The similarity in investment patterns (both in terms of stage and industry distribution) between Germany and the UK would seem to reinforce this. In the next three sections we formally analyze the relation between the sources of funding and the nature of VC investment activity. Section 4.1 discusses the way in which equations have been estimated, section 4.2 describes the results and section 4.3 provides an interpretation of the results.

4.1 Estimating the Determinants of VC Investments

Using pooled data for all four countries, we estimate the determinants of funds’ choice of investment stage as described in equation (3). We use two regression specifications. In the first one, the dependent variable is the average stage of investment, which is bounded to lie between one and three; we use Tobit regressions for this. The second specification is based on ordering all possible combinations of stages of investment reported by the funds and generating the “stage rank” as follows:

Fund	Investment	Strategy	Stage Rank
Early	Middle	Late	
1	0	0	1
1	1	0	2
1	0	1	3
1	1	1	3
0	1	0	3
0	1	1	4
0	0	1	5

We then estimate an ordered Probit regression corresponding to equation (3) with stage rank (rather than average stage) as the dependent variable.¹⁰

To allow for differences in institutional behavior between countries, we also estimate regressions based on equation (4) using both the Tobit and ordered Probit specifications, and allowing for the coefficients on the sources of funds to differ across the four countries.

An underlying assumption in this analysis is that VC firms in a particular country operate in a single market and face common demand functions. This is a questionable assumption for firms that operate at a regional rather than a national or international level. We therefore repeat the above regressions excluding VC firms that say that they operate at a regional level.

Turning to the determinants of VC investment in different industries, we estimate the following system of four seemingly unrelated equations:

$\text{industry}_{ij} = \text{function}(s \text{ sources of finance dummies and } k \text{ country dummies}),$
where the dependent variables are four sector-specific shares describing fund i 's investments in industry j . Note that because the right-hand-side variables are identical in all four equations, parameter estimates are identical to those in OLS regressions, although viewing the choice of industries as a “system” of inter-related decisions is convenient for expositional purposes. We also estimate the four equations separately using Tobit regressions and obtain very similar results.

Finally, we estimate the determinants of the geographical focus of investment using ordered Probit:

¹⁰ In our data, 17 percent of the funds are in Stage Rank 1, 14 percent in 2, 34 percent in 3, 24 percent in 4, and 11 percent in Stage Rank 5.

Geographical focus_{*ij*} = function (*s* sources of finance dummies and *k* country dummies),

where the dependent variable (defined above) takes the values 1 to 4 depending on the composition of the fund's domestic and foreign investments.

All four estimated equations can be viewed as reduced forms, representing the relation between the investment decisions of VC funds and their sources of finance.

4.2 Regression Results

Table 3 presents Tobit and ordered Probit estimates of equations (3) and (4). In Panel A, corresponding to equation (3), we include, in addition to sources of finance, individual country dummies; in Panel B, corresponding to equation (4), country-specific intercepts, as well as country-specific coefficients on the sources of finance are included.

The results in Panel A suggest that, in both specifications, bank finance is associated with later stage investment. VC funds that rely on pension funds also tend to favour later stages, whereas funds obtaining money from individual investors prefer earlier stages. Shifting from individual to bank finance is associated with an increase of 0.26 in average investment stage. This compares with a standard deviation of between 0.45 in average stage (in Germany) and 0.76 (in Japan). The shift therefore represents between 0.3 and 0.6 of a standard deviation. The within country relations between investment stage and source of funds are economically as well as statistically significant, although, as will become clear later, these figures hide substantial differences in the importance of sources of funds in various countries.

In contrast, the cross-country relations are dominated by the country dummy variables. The country dummy variables for Japan and Israel are highly statistically

significant. The one for Germany is not significant at the 10 percent level. The Israeli VC industry is associated with significantly earlier stage of investment than that in the UK, and Japan is associated with significantly later stage investment than the UK. The coefficients on the Israel and Japan country dummy variables are (in absolute value) much larger than those on sources of funds. For example, in the Tobit regression, the Israel coefficient is 5.5 times as large as the coefficient on bank finance and the Japan coefficient is 4.5 times larger. Moreover, the absolute magnitude of the country dummy coefficients is large: if the average UK fund were to “become Israeli” and face the Israeli entrepreneurs’ demand for finance, the average stage of its investments would have gone down from 2.1 to 1.3. If it were to “become Japanese”, the average stage would have gone up to 2.8.

By contrast, consider a British fund, which uses the sources of funds of the average German fund, but still faces the same “British” demand curve. The average stage of investment for this fund would have declined from 2.1 to 2.04. The results would be similar if the hypothetical British fund were to use the Japanese or Israeli sources of funds. Thus, differences in sources of finance contribute little to the cross-country differences in investment stage even though they are both statistically and economically important within countries.

To test the assumption that firms operate in a single market within a country and face common demand functions, we repeat the above regression excluding VC firms that stated that they operate at a regional rather than a national or international level. 93 observations are dropped but the results remain almost identical to those reported above. The size and significance of coefficients is little affected with the exception that pension funds are no longer significant at the 10 percent level.

To date, by imposing a single coefficient on each of the sources of finance across all countries, we are assuming similar preferences of equivalent institutions in different countries. In Panel B of Table 3, we relax this assumption by allowing the coefficients on sources of finance to differ between the four countries. The results indicate that the tendency of banks to favour later stage investments is a characteristic of UK and Israel VC firms but not of German and Japanese firms, where bank finance is not associated with significantly earlier or later stage investment. The coefficients on the bank variable in Israel and the UK are economically as well as statistically significant amounting to 0.65 and 0.59 of a standard deviation in investment stage respectively in the two countries.

UK pension funds and German insurance funds also invest in later stage activities. In contrast, Japanese funds financed by non-bank financial institutions invest relatively more in earlier stages; German and Japanese VC firms funded by individuals invest in earlier stages

Even in this specification, where institutional investment preferences are allowed to differ across countries, country intercepts for Japan and Israel are still significantly different from those in the UK. Again, Israel appears to favour earlier and Japan later investments than the UK, whereas German funds invest in similar stages to UK funds.

Table 4 reports seemingly unrelated regressions of VC investments by sector on sources of finance.¹¹ The table suggests that VC funds that rely on pension funds and insurance companies for finance (“institutional investors”) are less likely to invest in IT and software, and more likely to favour the life-sciences (insurance backed funds) and manufacturing (pension backed funds). The country dummy variables are,

¹¹ The results for individual sectors using Tobit regressions are very similar.

again, significant (relative to the UK), suggesting an Israeli and Japanese focus on IT, software and life sciences, away from manufacturing. German preference is towards the life sciences and away from investment in IT and software. As in the case of investment stage, the size of the country dummies is large in relation to the sources of finance.

Finally, we examine the relation between geographical focus of VC investment and sources of finance using an ordered probit regression. Table 5 shows that funds in the UK tend to invest more abroad than funds in other countries. We also find that bank financed VC funds tend to invest more locally, whereas funds financed by industrial corporations, insurance companies and individual investors tend to invest more abroad. Government funding is particularly closely associated with local investments. In contrast to investment stage and sector preference, the coefficients on some funding sources are of similar magnitude to the country dummy variables suggesting that source of finance is as critical a determinant of location of investment as the country of operation of a fund.

4.4 Interpretation of the Results

As described in section 2, our analysis assumes that all financial institutions within a country face the same “demand curve” for VC funds and differences between them (measured by sources of finance coefficients) reflect their attitudes towards risk. For example, if banks in the UK favour later stage investments relative to individual investors, this is because later stages are less risky and fit the banks’ “conservative” investment strategy.

In contrast, the country-specific intercepts are likely to capture differences in the availability of investment projects or alternative sources of finance in different

countries. For example, the greater propensity of VC funds using similar sources of finance to invest in earlier stages in Israel than the UK may reflect the greater availability of start-ups and early stage projects in Israel. Alternatively, Osnabrugge (1998) reports a large business angel market funding early stage investments in the UK. The relatively low level of early stage financing in the UK may therefore reflect the availability of this alternative source of finance rather than demand side considerations. However, provided that this affects the residual market available to all VC funds in the UK equally then there is no reason why it should influence the relation between types of investments made by VC firms and their sources of finance.

The above interpretation assumes that the elasticity of demand for VC finance by entrepreneurs is similar in the four countries. If, for some reason, demand is more elastic in one country than another, we would expect the coefficients on sources of finance to be all proportionately higher in that country. There is no evidence that this is the case. The methodology is therefore reasonably robust to alternative sources of finance and differences in demand for funds across countries.

The results in tables 3 and 4 suggest that sources of finance are significantly related to stages of finance and sector preferences within particular countries. Coefficients are frequently both statistically and economically significant. In contrast, the nature of the providers of finance to the VC industry is not the crucial factor in accounting for international differences in stage and sector preferences. For example, the presence of “institutional investors” (e.g. pension funds in the UK, insurance companies in Japan) is not a necessary condition for investment in early technological start-ups, as the comparison between Israel (where institutional investors are not important), the UK, and Japan demonstrates. Neither is the presence of large and powerful banks necessarily an obstacle to the provision of VC funds – the bank-

dominated VC industry of Germany seems to be quite similar to the UK in terms of sectors and technological stages of companies supported. Nor has the significant presence of banks in the Israeli system detracted from the provision of early stage finance there either.

Additional evidence that institutional factors do not drive international differences in types of VC investment activity comes from the geographical focus of funds. When we concentrate on funds that operate in an international market and therefore face common worldwide demand functions (i.e. with the geographical focus variable equal 4) then the country of origin of the fund as well as its sources of funds are generally insignificant determinants of the preferred investment stage.¹² This supports the view that the country dummies reflect domestic demand or alternative sources of finance considerations.

Finally, a comparison of the UK with Israel suggests that stock markets may not be crucial to VC investments. Investment in firms in their early technological stages is common in Israel, even though the IPO market has not been very active in recent years, and most high-tech companies go public in the US, on NASDAQ (Blass and Yafeh, 2001). In the UK, where the stock exchange is much larger and more liquid than the Tel Aviv stock exchange, investments in early stages of technological developments are comparatively rare.¹³

¹² The one exception is the Israel dummy, which remains significantly negative. This probably reflects the fact that Israeli VC funds are not as global as international funds in other countries. We also examine the investment strategies of six funds operating in both Germany and UK, and another fund operating in both the UK and Japan, finding no significant difference in the stage of investment of these funds in different countries. This could either reflect a general investment strategy adopted by funds irrespective of where they operate, or relatively similar demand conditions in Germany and the UK.

5. Conclusion

The purpose of this article has been to contrast the VC industry in four countries outside the US where VC industries are important or growing and to establish how institutional differences in the financing of VC firms are associated with differences in the types of activities that they fund.

To answer this question, we have collected a unique data source on VC firms and their sources of finance and provided cross-country controls that under certain assumptions allow us to identify the impact of sources of finance on VC activity. We have documented substantial differences across countries in the sources of funds used to finance VC investment. We have found that the sources of finance are significantly related to differences in VC activities within countries. However, we have also found that they only account for a small proportion of the differences in VC activities across countries. This suggests that a majority of international differences are attributable either to demand for funds (i.e. supply of entrepreneurs) rather than supply of financial institutions or to the availability of alternative sources of entrepreneurial finance (for example, business angels) that have not been identified in this study. The implication is that while there may be a matching of institutions with types of entrepreneurial activities within countries, international differences in entrepreneurial activity are primarily driven by other considerations.

¹³ Interestingly, BVK (2000) and EVCA (2000) suggest that IPO's are as important an "exit" mechanism in bank-dominated Germany as in the UK. 9 percent of all VC-backed companies end up as IPO in the UK and 7.5 percent in Germany.

References

- Allen, F. (1993), "Stock Markets and Resource Allocation," in C. Mayer and X. Vives, (eds.), *Capital Markets and Financial Intermediation* (Cambridge University Press, Cambridge).
- Allen, F. and D. Gale, 1999, "Diversity of Opinion and Financing of New Technologies," *Journal of Financial Intermediation*, Vol. 8, pp. 68-89.
- Black, S. and R. Gilson (1998), "Venture Capital and the Structure of Capital Markets: Banks versus Stock Markets," *Journal of Financial Economics*, Vol. 47, pp. 243-277.
- BVK (2000), *Venture Capital in Europa 1999* (German Venture Capital Association, Berlin).
- Blass, A. and Y. Yafeh (2001), "Vagabond Shoes Longing to Stray: Why Foreign Firms List in the US," *Journal of Banking and Finance*, Vol. 25, pp. 555-572.
- Botazzi, L. and M. Da Rin, M. (2001), "Venture Capital in Europe: Euro.nm and the Financing of European Innovative Firms," forthcoming, *Economic Policy*.
- Carlin, W. and C. Mayer (1999), "Finance, Investment and Growth," CEPR Discussion Paper No. 2223.
- EVCA (2000), *Mid-Year Survey, January-June 2000*, (European Venture Capital Association, available on the Internet at evca.com).
- Gompers, P. and J. Lerner (1998), "What Drives Venture Capital Fundraising?" *Brookings Papers on Economic Activity (Microeconomics)*, pp. 149-192.
- Gompers, P. and J. Lerner (1999), *The Venture Capital Cycle*, (Cambridge, MA, MIT Press).
- Hellman, T. and M. Puri (2000), "The Interaction between Product Market and Financing Strategy: The Role of Venture Capital," *Review of Financial Studies*, Vol. 13, pp. 959-984.
- IVA (2000), *2000 Yearbook*, (Israel Venture Capital Association, Tel Aviv).
- Jeng, L. and P. Wells (2000), "The Determinants of Venture Capital Funding: Evidence Across Countries," *Journal of Corporate Finance*, Vol. 6, pp. 241-289.
- Kaplan, S. and P. Stromberg (2000), "Financial Contracting Theory Meets the Real World: An Empirical Analysis of Venture Capital Contracts," NBER Working Paper No. 7660.
- Osnabrugge, M. (1998), "The Financing of Entrepreneurial Firms in the UK: A Comparison of Venture Capital and Business Angels Investment Procedures," unpublished D. Phil. Thesis, Hertford College, Oxford.

Figures 1 and 2

The returns on investment in activity j are on the vertical axis and the amount of capital is on the horizontal axis. The demand schedules describe entrepreneurs' demand for funds in two countries, A and B . The a 's are the amounts provided by each fund in each country. In Figure 1, the two supply schedules describe a case in which in each country there are two VC funds ($i=1$ and 2) which differ from each other in their investment preferences, but are identical across countries. In Figure 2, funds in each country have investment preferences, which differ between funds and across countries.

Figure 1

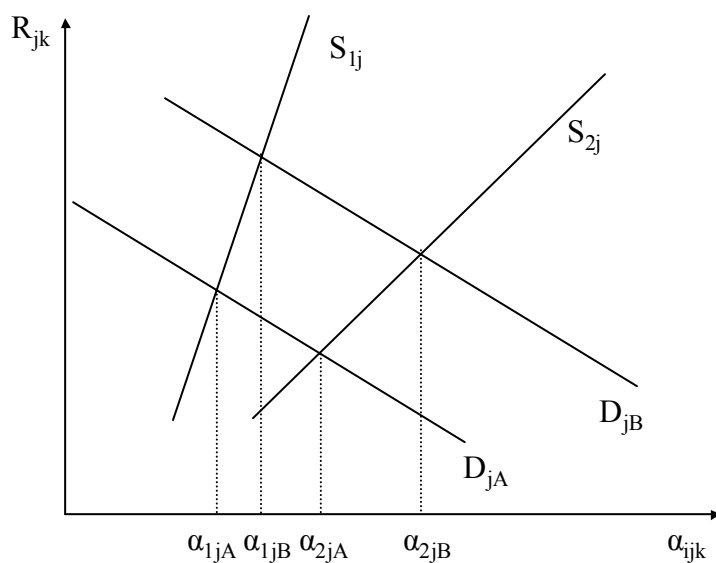


Figure 2

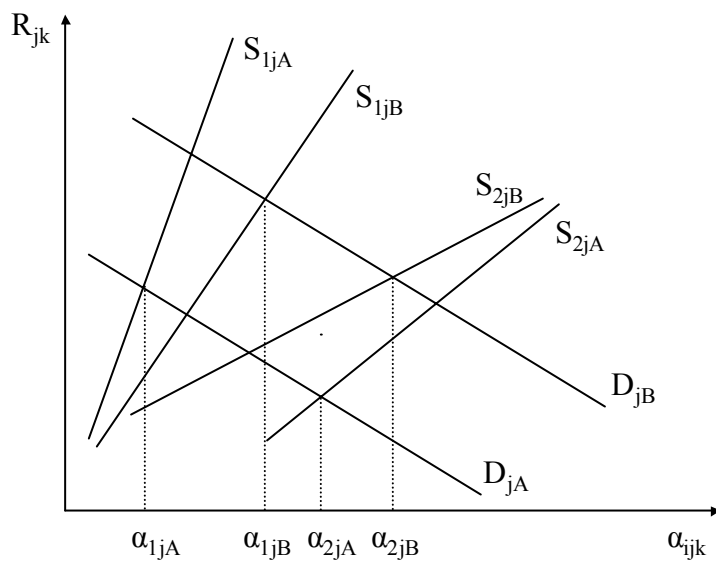


Table 1: Sources of External Funds for the VC Industry

This table reports sources of funds of VC firms in Germany, Israel, Japan and the UK based on binary responses to a question of whether or not a particular fund uses a certain source. Panel A records the fraction of funds that report using a given source. Panel B records the percentage of funds using one, two, three, or four or more sources. * and ** denote mean values which are statistically different from those of the UK at the 10 and 5 percent levels, respectively.

Panel A: Fraction of Funds using Particular Sources

	<i>Funds</i>	<i>Banks</i>	<i>Insurance Companies</i>	<i>Pension Funds</i>	<i>Corporate Investors</i>	<i>Individual Investors</i>	<i>Gov't</i>	<i>Other Institutions</i>
Germany	187	0.59**	0.22**	0**	0.16**	0.36*	0.09**	0.21**
Israel	119	0.51	0.11**	0.02**	0.60**	0.36	0.01**	0.54
Japan	62	0.56	0.43	0**	0.27	0.21**	0.03**	0.80**
UK	140	0.44	0.36	0.49	0.26	0.45	0.24	0.55

Panel B: Percentage of Funds using Particular Number of Sources

	<i>1</i>	<i>2</i>	<i>3</i>	<i>4 or more</i>
Germany	61%	22%	9%	8%
Israel	38%	27%	21%	15%
Japan	21%	39%	29%	11%
UK	35%	16%	15%	24%

Table 2: Characteristics of VC Investments

Table 2 reports the characteristics of VC investments based on discrete responses by firms. Panel A refers to investment stage and reports the proportion of funds investing in different investment stages: “early” refers to seed and start-up, “middle” to expansion and growth, and “late” to later stages. Panel B refers to the industry of investments and reports the proportion of funds investing in five groups of industries: life sciences, IT and software, electrical and semi-conductors, manufacturing and chemicals, and other industries. Panel C records the percentage of funds investing in one, two, three, or four or more industries. Panel D records the regional, national or international nature of investments by funds. It reports the percentage of funds investing in a region within a country, in several regions within a country, within a single continent, or in two or more continents (or in the case of Japan if more than 50 percent is invested abroad). * and ** denote mean values which are statistically different from those of the UK at the 10 and 5 percent levels, respectively.

Panel A: VC Investments by Stage

	<i>Funds</i>	<i>Early</i> <i>(1)</i>	<i>Middle</i> <i>(2)</i>	<i>Late</i> <i>(3)</i>	<i>Average</i> <i>Stage</i>
Germany	187	0.68**	0.89*	0.74	2.0**
Israel	98	0.93**	0.49**	0.28**	1.4**
Japan	57	0.15**	0.19**	0.65**	2.5**
UK	140	0.48	0.84	0.80	2.1

Panel B: VC Investments by Industry

	<i>Funds</i>	<i>Life</i> <i>Sciences</i>	<i>IT and</i> <i>Software</i>	<i>Elect and</i> <i>Semi-C.</i>	<i>Mnfg and</i> <i>Chemicals</i>	<i>Other</i> <i>Industries</i>
Germany	183	0.21**	0.23	0.16	0.23	0.17
Israel	95	0.24**	0.51**	0.16	0.08**	0.01**
Japan	56	0.26**	0.49**	0.05**	0.06**	0.14
UK	140	0.17	0.26	0.15	0.24	0.19

Panel C: Percentage of Funds Investing in Certain Number of Industries

	<i>1</i>	<i>2</i>	<i>3</i>	<i>4 or more</i>
Germany	9%	16%	15%	60%
Israel	39%	23%	17%	21%
Japan	3%	12%	42%	42%
UK	11%	7%	7%	75%

Panel D: VC Investments by Region

Percentage of Funds Investing in Different Locations

	<i>Funds</i>	<i>Region within Country (1)</i>	<i>Country only (2)</i>	<i>County and Continent (3)</i>	<i>Worldwide (4)</i>	<i>Average</i>
Germany	187	34%	32%	18%	17%	2.18*
Israel	97	1%	67%	25%	7%	2.35*
Japan	55	13%	44%	38%	5%	2.28*
UK	139	16%	24%	35%	24%	2.68

Table 3: Estimates of the Determinants of the Stage of Investment

This table reports the results of pooled regressions of stages of investment on sources of funds reported by individual VC funds. The first column reports the results of Tobit regressions of average stage of investments of a fund (which lies between 1 and 3) on the zero-one dummy variables of sources of funds. The second column reports the results of an ordered Probit on stage rank, which lies in the range of 1 to 5. The constant is measured relative to the UK. Panel A reports the results of pooled regressions for all four countries with individual country intercepts. Panel B reports pooled regressions, allowing the slope coefficients as well as the intercepts to vary across countries. Standard errors are in parentheses. * and ** denote statistical significance at the 10 and 5 percent levels, respectively

Panel A: Regressions with the Same Sources of Funds Coefficients for all Countries

	<i>Avg. Stage</i> (Tobit)	<i>Stage Rank</i> (O. Probit)
CONSTANT	Yes	Yes
BANK	0.14** (0.07)	0.19* (0.10)
INSURANCE	0.11 (0.08)	0.17 (0.12)
PENSION	0.24** (0.12)	0.38** (0.19)
OTHER	-0.01 (0.07)	-0.01 (0.11)
CORPORATE	-0.10 (0.08)	-0.17 (0.12)
INDIVIDUAL	-0.12* (0.07)	-0.21** (0.12)
GOVNMEN	-0.11 (0.11)	-0.16 (0.16)
GERMANY	-0.10 (0.10)	-0.20 (0.15)
ISRAEL	-0.79** (0.12)	-1.16** (0.18)
JAPAN	0.65** (0.14)	0.97** (0.21)
N	482	482
PSEUDO R ²	0.14	0.11

Panel B: Regressions with Country-Specific Coefficients

	<i>GERMANY</i>		<i>ISRAEL</i>		<i>JAPAN</i>		<i>UK</i>	
	Avg. Stage (Tobit)	Stage Rank (O. Probit)	Avg. Stage (Tobit)	Stage Rank (O. Probit)	Avg. Stage (Tobit)	Stage Rank (O. Probit)	Avg. Stage (Tobit)	Stage Rank (O. Probit)
CONSTANT	2.06 (0.11)	0.08 (0.24)	1.01** (0.18)	-1.43** (0.33)	3.68** (0.34)	2.62** (0.55)	1.98** (0.10)	N/A
BANK	-0.02 (0.11)	-0.04 (0.18)	0.34** (0.17)	0.43* (0.26)	-0.18 (0.22)	-0.27 (0.33)	0.30** (0.12)	0.47** (0.20)
INSURANCE	0.21* (0.12)	0.34* (0.20)	0.12 (0.24)	0.25 (0.38)	0.07 (0.21)	0.08 (0.32)	-0.02 (0.16)	-0.07 (0.25)
PENSION	N/A	N/A	-0.09 (0.37)	-0.22 (0.57)	N/A	N/A	0.32** (0.16)	0.55** (0.25)
OTHER	0.08 (0.12)	0.16 (0.20)	-0.01 (0.16)	0.00 (0.26)	-0.91** (0.30)	-1.39** (0.47)	-0.07 (0.14)	-0.11 (0.21)
CORPORATE	-0.27** (0.13)	-0.47** (0.22)	0.07 (0.16)	0.04 (0.25)	0.08 (0.24)	0.15 (0.37)	-0.25 (0.16)	-0.38 (0.25)
INDIVIDUAL	-0.17 (0.11)	-0.31* (0.17)	0.05 (0.18)	0.05 (0.27)	-0.58 (0.25)	-0.93** (0.38)	-0.09 (0.12)	-0.18 (0.20)
GOV	-0.29* (0.16)	-0.49* (0.26)	N/A	N/A	N/A	N/A	0.13 (0.15)	0.21 (0.23)
N	482							
PSEUDO R ²								
Tobit	0.18							
Probit	0.14							

Table 4: The Determinants of Industry Investment Shares

This table reports the results of seemingly unrelated regressions of the share of a fund's investment in five different sectors (life sciences, IT and software, electronics and semiconductors, manufacturing and services and other sectors) on sources of funds. * and ** denote statistical significance at the 10 and 5 percent levels, respectively

	<i>Life Sciences</i>	<i>IT and Software</i>	<i>Electronics</i>	<i>Manufacturing</i>
CONSTANT	Yes	Yes	Yes	Yes
BANK	-0.03 (0.02)	0.01 (0.02)	0.02 (0.01)	0.01 (0.02)
INSURANCE	0.07** (0.02)	-0.06* (0.03)	-0.02 (0.02)	0.02 (0.02)
PENSION	0.06 (0.04)	-0.11** (0.05)	0.02 (0.02)	0.08** (0.03)
OTHER	-0.01 (0.02)	0.02 (0.03)	-0.00 (0.14)	0.00 (0.02)
CORPORATE	0.00 (0.02)	0.05* (0.03)	0.01 (0.14)	-0.04** (0.02)
INDIVIDUAL	-0.03 (0.02)	0.06** (0.03)	0.00 (0.01)	-0.05** (0.02)
GOV	-0.01 (0.03)	-0.04 (0.04)	0.02 (0.02)	0.01 (0.02)
JAPAN	0.10** (0.04)	0.18** (0.05)	-0.09** (0.03)	-0.16** (0.03)
GERMANY	0.07** (0.03)	-0.09** (0.04)	0.02 (0.02)	0.02 (0.02)
ISRAEL	0.11* (0.03)	0.16** (0.04)	0.00 (0.02)	-0.12** (0.03)
N			474	
R ²	0.05	0.21	0.07	0.25

Table 5: Ordered Probit Estimates of the Determinants of Geographical Focus

The table reports the results of regressions of geographical focus (which takes values between 1 and 4, where 1 corresponds to investment within a region within a country, 2 to investment in one country, 3 to investment in a continent, and 4 to worldwide investments) on sources of funds. * and ** denote statistical significance at the 10 and 5 percent levels, respectively

CONSTANT	No
BANK	-0.21** (0.10)
INSURANCE	0.28** (0.12)
PENSION	-0.02 (0.20)
OTHER	0.02 (0.11)
CORPORATE	0.56** (0.12)
INDIVIDUAL	0.19* (0.10)
GOV	-0.70** (0.17)
GERMANY	-0.52** (0.15)
ISRAEL	-0.52** (0.18)
JAPAN	-0.41* (0.20)
N	478
PSEUDO R ²	0.06