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FINANCE OF SMALL BIO-PHARMACEUTICAL INDUSTRY IN FINLAND – DESCRIPTIVE ANALYSIS**

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ABSTRACT: This study investigates the capital and ownership structures of small and medium-sized pharmaceutical-related biotechnology firms (bio-pharmaceutical companies) in Finland. These structures are also analyzed taking into account general characteristics and intangible assets of the business activities in the industry. Relatively young companies are typically owned by persons that are active in business, private venture capital companies, and government institutions. Older firms are mostly owned by other non-financial companies. The major capital loan supplier has been TEKES, the National Technology Agency of Finland. Equity finance from private venture capital companies and governmental sources has supported growth in research and development activities in the companies examined. However, the companies owned mostly by non-financial companies have been able to generate relatively high sales. These firms are also anticipated to have the highest sales potential over the next 5 years. The results here are contrasted with explanations of capital structure found in the literature. No single theory can by itself explain the capital and ownership patterns within Finnish bio-pharmaceutical companies. Instead, the literature suggests many explanations for the observed ownership patterns. For example, different patterns can be related to the owners' willingness to monitor the managers and support activities with high earning prospects.

Key Words: Biotechnology, capital structure, finance, intangible assets, pharmaceutical industry.

HERMANS, Raine, **PIENTEN JA KESKISUURTEN LÄÄKEALAN BIOTEKNIIKKAYRITYSTEN RAHOITUSLÄHTEET SUOMESSA.** Helsinki: ETLA, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 2004, 22 s. (Keskusteluaiheita, Discussion Papers, ISSN 0781-6847; No. 888).

TIIVISTELMÄ: Tämä tutkimus selvittää pienten ja keskisuurten lääkealan bioteknologiayritysten rahoitusrakenteita Suomessa. Lisäksi rahoitusrakenteiden merkitystä analysoidaan alan liiketoiminnan erityispiirteiden kannalta. Alan rahoitusrakenteille on tyypillistä, että nuorten yritysten merkittävimpiä omistajia ovat liiketoiminnassa mukana olevien henkilöiden lisäksi yksityiset pääomasijoitusyhtiöt sekä julkisen sektorin pääomasijoitusinstituutiot. Iäkkäämpien yritysten suurimpina omistajina ovat toiset yritykset. Merkittävin yksittäinen pääoma- ja muiden lainojen tarjoaja on ollut Tekes. Yksityisten pääomasijoitusyhtiöiden ja julkisen sektorin toimijoiden osakerahoitus on tukenut yritysten tutkimus- ja kehitystoiminnan kasvua. Kuitenkin muiden kuin rahoitusalan yritysten omistamat bioteknologiayritykset ovat onnistuneet saamaan aikaan myyntiä muita yrityksiä enemmän. Näillä yrityksillä odotetaan olevan huomattavin myynnin myyntipotentiaali myös lähitulevaisuudessa (5 vuoden kuluessa). Tuloksia peilataan myös rahoitusrakenteiden syitä selittävään kirjallisuuteen. Yleispätevää lääkealan bioteknologiayritysten rahoitusrakenteita selittävää teoriaa ei kirjallisuudesta yksiselitteisesti löydy. Sen sijaan yksittäisille aineiston komponenteille löytyy luontevia selityksiä esim. siitä miten eri tavoin omistajat voivat pyrkiä valvomaan yritysjohdon käyttäytymistä ja tukemaan sellaista toimintaa, joka synnyttää tulevaisuuden tuotto-odotuksia. Deskriptiivisen analyysin perusteella "käänteinen nokkimisjärjestysteoria" vaikuttaa lupaavalta ehdokkaalta selittämään vieraan pääoman ehtoisen ja oman pääoman ehtoisen rahoituksen suhdetta t&k-intensiivisten biotekniikkayritysten kohdalla.

Avainsanat: aineeton varallisuus, biotekniikka, lääketeollisuus, pääomasijoitukset

1. Introduction

In Finland a great deal of emphasis has been placed in recent years on biotech research in scientific circles as well as in biotech companies, the number of which has grown sharply. The biotech sector has been an interesting one recently owing to the high growth expectations and risks related to this field. This sector is anticipated to spark a new phase of technological development that will have a pronounced impact on economic growth. ETLA carried out a survey of biotech companies in spring 2002. This study presents the main findings about capital structures and business characteristics of bio-pharmaceutical companies. Overviews of the Finnish biotech industry have been made by e.g. Kuusi (2001), Schienstock and Tulkki (2001) as well as Hermans and Luukkonen (2002). The study at hand has been influenced by a study on the capital structure of Finnish small and medium-sized companies (Hyytinen and Pajarinen 2002), a study depicting capital structures in the biotech industry (Hermans and Tahvanainen 2002) and a study on the SME sector in the US (Berger and Udell 1998). Furthermore, Tahvanainen (2003) has analyzed the capital structures prevailing in the Finnish biotech industry. The study at hand focuses on the capital structure of biotech companies engaged in pharmaceutical-related activities at the end of 2001 (see also Hermans 2003).

The study has two main aims. The first aim is to identify the sources of financing for Finnish bio-pharmaceutical companies. The second aim is to depict how various sources of financing are related to the intangible assets and other characteristic features of these companies. In order to fulfill the first aim the sources of financing and capital structure are evaluated with respect to the companies' age and size as well as their research intensity. In order to accomplish the second aim, principal component analysis is used to evaluate how sources and types of financing are related to the companies' intangible assets. The study also sheds light on the capital structures from the perspective of the financial literature.

The study is organized as follows. After the introduction, in Section 2 we provide an overview of the bio-pharmaceutical sector. The characteristics of the small and medium-sized companies in this sector are compared to those of the overall biotech industry and SMEs as a whole in the Finnish economy. Section 3 describes the capital structures of bio-pharmaceutical companies and the results of the survey are compared with those reported in the finance literature. Section 4 presents the findings of the principal component analysis and presents the interconnections between capital structures and business characteristics. Section 5 discusses the results of the study.

2. Characteristics of Bio-pharmaceutical Sector

The data used in this study is derived from on a database compiled by ETLA covering financial and business-related information on 84 companies operating in the biotechnology sector. An overview of the data is presented in Hermans and Luukkonen (2002). From the database we selected 42 small and medium-sized firms that indicated they are part of the pharmaceutical industry or that their clients or subcontractors are in the pharmaceutical industry. ETLA's survey was carried out in early 2002 and its information is based primarily on the situation at the end of 2001. The information from financial statements has been cross-checked with the trade register of the National Board of Patents and Registration of Finland.

The number of personnel in small and medium-sized[1] bio-pharmaceutical companies is relatively high compared to other Finnish SMEs as a whole, but their sales revenues are lower on average than those of companies in other industries. Almost 30 per cent of the bio-pharmaceutical companies employ over 20 persons while the corresponding share for all SMEs is 15 per cent. Despite the fairly high number of employees, the turnover of biotechnology companies is less than other companies. The turnover of about 45 per cent of the bio-pharmaceutical companies is less than EUR 200,000 while the corresponding share for SMEs as a whole is about 15 per cent. The sales of the bio-pharmaceutical sector are oriented more toward foreign markets than sales of other companies on average.

The companies of the bio-pharmaceutical sector are comparatively young. Slightly more than a third of the biotech companies have been founded in 1997 or afterwards, while the corresponding share for SMEs as a whole is some 14%.

The nature of the bio-pharmaceutical sector as a seller of scientific research is seen especially when we look at companies' outlays on R&D[2] as a percentage of their total expenses. Almost eight out of ten of the biotech companies have R&D outlays amounting to more than 10 per cent of their total expenses. On the other hand, over half of all Finnish SMEs have no R&D expenditures at all. Furthermore, three-fourths of the bio-pharmaceutical companies have patents or patents pending, while 94 % of all SMES have neither of these.

Commercialization of products by bio-pharmaceutical companies is geared primarily toward the future, in contrast with other SMEs. Active research activity is ordinarily anticipated to generate expectations of future revenues. Otherwise it would not be worthwhile for the company to carry out R&D activity at all. On the other hand, the emphasis on commercialization geared toward the future will increase the business risks, which will in turn increase the yield requirements of investors. Given the revenue expectations of entrepreneurs and the yield requirements of investors, it is understandable that 86 per cent of the bio-pharmaceutical companies expect turnover to rise over the next five years at an average annual rate exceeding 10 per cent. Only about a fifth of all SMEs expect turnover to grow faster than 10 per cent per annum.

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1 Below we use the term SMEs to denote small and medium-sized enterprises. A company is called small or medium-sized if two of the following three conditions are met: the company has a maximum of 250 employees, its turnover does not exceed EUR 40 million and its total assets are less than EUR 27 million.

2 Below research and development activities will be called R&D.

Table 1. Comparison of Finnish Bio-pharmaceutical SMEs and SMEs as a whole

		Bio-pharma-ceutrical SMEs	Total SMEs[3]
		%	%
Number of personnel	<5	33 %	44 %
	5-20	38 %	41 %
	>20	29 %	15 %
Turnover, million euro	< 0.2	45 %	15 %
	0.2-1.5	40 %	56 %
	1.6-8.0	12 %	24 %
	>8	2 %	5 %
Exports / turnover	0 %	43 %	70 %
	0-1 %	2 %	22 %
	2-5 %	7 %	4 %
	6-10 %	0 %	2 %
	>10 %	45 %	3 %
	Unknown	2 %	0 %
Age of company, years	0-2	14 %	5 %
	3-4	21 %	9 %
	5-24	64 %	70 %
	>24	0 %	16 %
R&D expenditures / total costs (Total SMEs = R&D expenditures / turnover)	0 %	5 %	53 %
	0-1 %	2 %	23 %
	2-5 %	5 %	13 %
	6-10 %	7 %	3 %
	>10%	79 %	6 %
	Unknown	2 %	0 %
Company has patents or patent applications	Yes	74 %	6 %
	No	26 %	94 %
Company's expected turnover growth over next 5 years (Total SMEs = next 3 years	<0 %	0 %	1 %
	0-1 %	2 %	31 %
	2-5 %	0 %	20 %
	6-10 %	10 %	23 %
	>10 %	86 %	21 %
	Unknown	2 %	5 %
Total observations in sample		42	754

[3] Hyytinen and Pajarinen (2002) used sector-specific data on Finnish companies to uncover the real structure of Finnish SMEs. Hermans and Tahvanainen (2002) weighted the data according to the age of the companies. In this study we follow the latter approach. The number of companies and the age of the entire population is known. This is compared to the number of companies in the sample in the various age categories. The weights are obtained as follows: $\frac{n_{total(t)}}{n_{sample(t)}}$. The term n denotes the number of companies in the total population and the sample. Term t denotes the three groups (t=1,2,3) in order of age. Group 1 consists of companies founded in 1997-2001. Group 2 is comprised of companies founded in 1991-1996. Group 3 is for companies older than this. Using the weights described above we can estimate the capital structure for the entire population of bio-pharmaceutical companies.

3. Capital Structure and Financial Sources

In this section we investigate the financing received by bio-pharmaceutical companies broken down by type of capital. Because almost half of the companies made a loss in the fiscal period evaluated, the losses realized reduced the amount of equity in the balance sheet. Since we want to assess how much has been invested in the companies in the form of equity and capital loans and other forms of debt, the realized profits or losses are not taken into consideration at all in our study. Thus the capital structure presented in Table 2 does not correspond to the figures obtainable directly from the balance sheets. In this study we investigate the financing coming from investors. Revenue financing is evaluated from the viewpoint of turnover not profitability. Our study emphasizes the special nature of the bio-pharmaceutical sector as a young research-intensive field. For example, Himmelberg and Petersen (1994) show using US data on publicly listed companies that the internal financing of companies is a significant form of financing for R&D activities.

Table 2. Capital structure by age and size of bio-pharmaceutical companies.

	Equity	Capital loans	Loans	Total financing (million euro)
Total	70.6 %	18.3 %	11.1 %	225.4
0-4 years	77.1 %	10.5 %	12.4 %	134.9
5-8 years	71.0 %	27.9 %	1.1 %	59.3
9-24 years	41.4 %	33.6 %	25.0 %	31.2
Small	49.9 %	36.5 %	13.7 %	20.6
Large	72.6 %	16.5 %	10.9 %	204.8

Equity and capital loans are prominent forms of financing in all bio-pharmaceutical companies (Table 2). Equity and capital loans are both considered part of the total shareholders' equity. A company pays a dividend to shareholders and interest on capital loans only if it has profits that it can pay out. Bio-pharmaceutical companies have relatively low levels of indebtedness. Loans account for 11 per cent of total financing on average. Loan financing, which is classified as a liability, is relatively higher in older companies, a fourth of whose capital comes from loans.[4]

The total equity financing of SMEs operating in the pharmaceutical industry is estimated to be slightly less than EUR 160 million (Table 3). Most of the companies are owned by persons actively engaged in the business, private venture capital companies and government institutions providing venture capital, mainly SITRA[5]. Especially in older companies the owners are likely to be a non-financial company. Other companies own over 60 per cent of the shares of bio-pharmaceutical companies that are more than 8 years old. The ownership of both private venture capital companies and government institutions is significant among relatively young companies. The investments of venture capitalists appear to enable companies to hire additional employees.

[4] For an overview of theories on companies' capital structures see e.g. Myers (1984; 2001).
[5] SITRA denotes the Finnish National Fund for Research and Development.

Table 3. Equity financing by age and size of bio-pharmaceutical companies.

	Persons active in the business	Other persons	Private venture capital company	Other financial institution	Other company	Government institution	Other	Total share capital (million euro)
Total	25.6 %	4.8 %	31.7 %	2.6 %	10.4 %	23.6 %	1.3 %	159.0
0-4 years	27.5 %	4.1 %	42.0 %	0.3 %	0.9 %	25.0 %	0.2 %	104.0
5-8 years	22.3 %	7.6 %	13.6 %	8.5 %	17.8 %	25.9 %	4.2 %	42.1
9-24 years	21.4 %	0.6 %	8.6 %	2.0 %	62.4 %	4.9 %	0.2 %	12.9
Small	42.5 %	6.2 %	7.4 %	0.0 %	17.0 %	22.1 %	4.8 %	10.3
Large	24.5 %	4.7 %	33.4 %	2.8 %	9.9 %	23.7 %	1.1 %	148.8

The capital loans supplied to bio-pharmaceutical companies have come almost entirely from the public sector. The largest supplier of capital loans is TEKES (National Technology Agency of Finland). TEKES accounts for over 80 per cent of the capital loans supplied to this sector. When SITRA is taken into consideration in the calculations, the public sector's share of capital loans rises above 95 per cent. The role of SITRA as a source of capital loans is especially pronounced in small companies with less than 20 employees.

Table 4. Capital loan financing by age and size of bio-pharmaceutical companies.

	Private venture capital company	Foreign venture capital company	Sitra	Tekes	Finnvera	Other government institution	Other	Total capital loans (million euro)
Total	1.5 %	0.0 %	15.4 %	80.3 %	0.2 %	1.0 %	1.6 %	25.1
0-4 years	1.1 %	0.1 %	18.9 %	76.0 %	0.2 %	1.5 %	2.2 %	16.7
5-8 years	0.0 %	0.0 %	0.0 %	94.0 %	0.0 %	0.0 %	6.0 %	0.6
9-24 years	2.5 %	0.0 %	9.0 %	88.5 %	0.0 %	0.0 %	0.0 %	7.8
Small	7.0 %	0.0 %	40.0 %	41.3 %	1.5 %	8.9 %	1.3 %	2.8
Large	0.8 %	0.1 %	12.3 %	85.3 %	0.0 %	0.0 %	1.6 %	22.3

The most prominent source of loans for bio-pharmaceutical companies is accounts payable from other companies and loans from TEKES[6]. Accounts payable are usually related to business expenses. In Finland payment times for purchases are shorter than in many other countries. The relatively high portion for accounts payable tells that loan financing is not a popular means of financing in this sector where business risks (and also the risk related to repayment of the loan) are considerable. It is also typical of the bio-pharmaceutical sector that the company's revenue expectations and assets are based to a large extent on intangible assets and know-how, so companies seldom have collateral they can pledge to back loans. For example, bank loans are only taken by older bio-pharmaceutical companies, the operations of which have to a certain extent stabilized and that have accumulated tangible assets. Companies in business for over 8 years ac-

[6] TEKES is National Technology Agency of Finland.

count for about 77 per cent of the sector's tangible assets, such as machinery and equipment.

Table 5. Loan financing by age and size of bio-pharmaceutical companies.

	Bank	Other financial institution	Other company	Other debt	Tekes	Finnvera	Other government institution	Bond	Other	Total loan financing (million euro)
Total	2.6 %	2.7 %	0.5 %	35.8 %	23.3 %	2.1 %	8.1 %	0.8 %	24.1 %	41.2
0-4 years	0.0 %	2.9 %	0.0 %	21.1 %	25.9 %	1.3 %	2.1 %	0.0 %	46.7 %	14.2
5-8 years	0.0 %	0.0 %	0.2 %	51.8 %	29.0 %	1.1 %	13.2 %	0.0 %	4.8 %	16.6
9-24 years	10.3 %	6.6 %	1.6 %	30.3 %	10.8 %	4.6 %	8.5 %	3.3 %	24.1 %	10.5
Small	9.8 %	6.1 %	0.6 %	14.3 %	14.6 %	11.4 %	18.0 %	0.0 %	25.2 %	7.5
Large	1.0 %	1.9 %	0.5 %	40.5 %	25.2 %	0.0 %	5.9 %	1.0 %	23.9 %	33.7

Table 6. Equity financing by realized turnover, i.e. sales revenue, and export intensity of bio-pharmaceutical companies.

	Persons active in the business	Other persons	Private venture capital company	Other financial institution	Other company	Government institution	Other	Total share financing (million euro)
Turnover under 1.5 million euro	26.3 %	5.1 %	33.6 %	2.6 %	5.9 %	25.0 %	1.4 %	147.6
Turnover over 1.5 million euro	16.8 %	0.6 %	7.4 %	2.3 %	67.4 %	5.5 %	0.1 %	11.5
Exports / turnover under 10%	26.9 %	5.4 %	36.6 %	2.9 %	0.7 %	27.2 %	0.4 %	133.4
Exports / turnover over 10%	18.8 %	1.5 %	6.3 %	1.0 %	60.9 %	5.2 %	6.2 %	25.6

The most prominent source of capital for bio-pharmaceutical companies is equity financing. Companies obtained over 70 per cent of their financing in this form. Almost all of the capital loans, i.e. subordinated loans on equity terms, came from government institutions. Loan financing was relatively modest and over a third of the loans were related to daily business operations. In contrast, over 60 per cent of the equity of older firms (founded 9-24 years ago) is held by non-financial companies (Table 3). According to Table 2, they have relatively more loan financing and over 10 per cent of the loans are from banks (Table 5). This corresponds with the principal-agent theory regarding the relationship between a company's owners and management presented by Jensen (1986). By taking a loan the company's owner (in this case another company) seeks to monitor the behaviour of the management and constrain spending by the management. On the other hand, according to Jensen and Meckling (1976), the high proportion of share capital provided by persons actively engaged in the business can be explained by constraints on fringe benefits stemming from their high ownership stakes. Owing to the pivotal role of equity financing as a whole, we will look at the significance of the ownership structure in more detail in the next section.

As a rule, few bio-pharmaceutical companies have very high levels of turnover yet. Most of the equity financing is focused on firms with turnover less than EUR 1.5 million. Those companies that have succeeded in ringing up some sales are mostly owned by non-financial companies. These companies primarily export their products or services abroad. Other investor groups have made most of their investments in firms that do not yet have significant turnovers.

R&D activities and ownership of intangible assets is of key importance from the viewpoint of the companies' revenue expectations. R&D is of pivotal importance in the pharmaceutical sector owing to the long lags in product development. The time from an innovation spurring development of a drug to the launch of the final product on the market may take 10-15 years. This inevitably means that a start-up firm's R&D activities and intangible assets are of pivotal importance when assessing the firm's expected stream of revenues and consequent present value. For example, Garner, Nam and Ottoo (2002) evaluate the connection between R&D intensity the company's market value by using growth options.

Table 7. Equity financing of bio-pharmaceutical companies broken down by realized R&D intensity[7] and possession of patents and patent applications.

	Persons involved in company's business	Other persons	Private venture capital company	Other financial institution	Other company	Government institution	Other	Total share financing (million euro)
Low R&D intensity	4.5 %	0.2 %	0.0 %	0.0 %	93.8 %	1.5 %	0.0 %	7.5
High R&D intensity	26.6 %	5.0 %	33.3 %	2.7 %	6.2 %	24.7 %	1.4 %	151.6
No patents	25.2 %	7.8 %	0.0 %	0.0 %	46.8 %	12.8 %	7.4 %	3.4
Patents	25.6 %	4.7 %	32.4 %	2.7 %	9.6 %	23.9 %	1.2 %	155.6

Owing to the nature of the biotech industry, most of the companies have a relatively high level of R&D activity. Financiers have stressed the importance of R&D activity by companies as a way of boosting future revenue expectations (Table 8 high R&D intensity). On the other hand, the R&D intensity of the companies may be a signal to investors about future revenue expectations, which makes the company an interesting investment target.

Biotech R&D activity spawns patent applications but, on the other hand, companies possessing intangible assets are attractive investment opportunities. For this reason it is not clear whether most of the patent applications and patent ownership are mainly a result of research financed by equity or whether the company has been an interesting investment candidate and obtained equity financing because it has had intangible assets such as patents already when the company was founded. The investigation of cause-effect relationships between intangible assets and equity financing would require time series data. In this study we have at our disposal only cross section data from the end of 2001 so that we must satisfy ourselves with discussing the causality relationships only in general terms. Luukkonen (2003) states that holdings of patent applications and pat-

[7] A company's R&D intensity is high when research and development costs are over 10 per cent of total costs.

ent are a necessary condition for a biotech company to obtain equity financing from private venture capital companies.

Table 8. Equity financing of bio-pharmaceutical companies by expected turnover in 5 years and expected annual growth in turnover

	Persons in business	Other persons	Private venture capital company	Other financial institution	Other company	Government institution	Other	Total equity investments (million euro)
Expected sales in five years below 1.5 million euro	26.4 %	6.4 %	36.1 %	3.3 %	0.1 %	27.4 %	0.2 %	107.4
Expected sales in five years above 1.5 million euro	23.9 %	1.4 %	22.6 %	1.1 %	31.6 %	15.9 %	3.5 %	51.7
Expected rate of growth less than 25% per annum	24.1 %	4.5 %	38.6 %	0.3 %	8.7 %	23.5 %	0.3 %	90.3
Expected rate of growth greater than 25% per annum	27.6 %	5.2 %	22.8 %	5.6 %	12.5 %	23.8 %	2.6 %	68.7

A company's present value is based on the expectations of the future stream of revenues generated by its business activities. In Table 9 the ownership structure is broken down by the sales expectations indicated by the company. First let us look at the company's own sales expectations in five years. A critical threshold of 1.5 million is set for expected sales after five years. Persons actively engaged in the business own about a fourth of the companies with both low and high revenue expectations. Private venture capital firms own slightly over a one-third stake in the companies with revenues anticipated to remain below EUR 1.5 million over the next five years but they account for slightly over a fifth of the ownership in companies with higher revenue expectations over the same time horizon. The role of government sources of venture capital, especially SITRA, will grow in connection with companies whose turnover is not expected to surpass 1.5 billion by the year 2006. On the other hand, non-financial companies have invested heavily in companies whose sales expectations are relatively high.

In this section we have presented the capital structure of companies in the bio-pharmaceutical sector broken down by factors describing the nature of the business. In the next section we will seek to form a more systematic overview of the above-described capital and ownership structures using statistical means.

4. Financial Sources and Business Models

4.1 Variable Selection

The book value of a company is often below its market value determined, for example, on the financial markets (see Hall 2001). Investors seek to make investment decisions based on expectations of future returns. The future return expectations regarding a company can be assessed on the basis of financial statements and intangible assets at the disposal of the company. The intangible assets of a company are seldom booked at full value on the official balance sheet. In a broad sense the whole intellectual capital of a company can be regarded as an intangible asset. (e.g. Edvinsson – Malone 1997; Sveiby 1997).

A company's intellectual capital can be divided into human capital, structural capital and relational capital (e.g. Saint-Onge, Armstrong, Petrash, and Edvinsson in Edvinsson and Malone 1997). Human capital comprises the knowledge of the personnel. Biotechnology is a science-based sector where management of know-how is given more emphasis than in many other sectors. The total number of personnel and number of employees with doctorate degrees depict the company's internal critical mass. The business experience of the CEO in years measures the business knowledge of the management while the educational level of the CEO signifies formal or practical competence.

Structural capital includes the company's internal organizational structures and organization of activities whereby it seeks to use human capital efficiently. In this connection, structural capital is measured by R&D costs, the number of patents and patent applications as well as the age of the company (in years). In addition we look at the intensity of research and patents: the number of patents and patent applications is calculated as a percentage of the number of personnel and R&D expenditures are calculated as a share of the company's total costs.

Relational capital is comprised of the company's external relationships. The most critical aspect of relational capital is the company's possibilities to exploit the marketing potential of its products, i.e. client relations. Without customers the company is not viable, even if the activities of its highly educated personnel is otherwise well organized. Ahonen (2000) and Hussi (2001) list the following mechanisms of value creation. They divide intangible assets into generative intangible assets and commercially exploitable intangible assets. The value of commercially exploitable intangible assets can be measured also by the ability to generate a return. With this in mind, the sales volume of the company in 2001 is evaluated separately in under the heading of business performance. On the other hand, generative intangible assets (such as intellectual capital) are not expected to generate a return until later in the future. For this reason we look at the company's expected turnover in the year 2006. The ability to take advantage of international markets is measured by exports' share of total turnover.

The return expectations of bio-pharmaceutical companies may often be several years away. For this reason market potential can be assessed from the perspective of financing received. If financiers have accepted the company's business strategy and offered the company financing, this signifies that the plan is strategically well founded and credible. Here we evaluate whether the company's activities have been financed by SITRA

or TEKES, how much financing the company has received for R&D from government institutions as well as how large a share of its total R&D expenditures is financed by government institutions. Furthermore, the significance of various financing sources is depicted under the heading of capital structures by the amount of financing raised via equity capital and capital loans. The capital structure of the company is also depicted by the debt-equity ratio.

In young bio-pharmaceutical companies, there is growing emphasis on joint research with other experts in the field. The critical mass needed in R&D can be achieved also via joint research with other experts in the field. Almost all companies engage in collaboration with some domestic research institutions or universities. In the statistical analysis we assess the prevalence of international collaboration by looking at whether the company collaborates with foreign academic institutions. The nature of collaboration is also depicted by whether the company engages in R&D collaboration with subcontractors or clients.

The company's external relational capital also includes possibilities to recruit skilled labour. This is measured by whether the company indicates that it has encountered difficulties in hiring employees. The company's external relations are also assessed as to whether the company's accounting is handled by one of the big five accounting firms.

4.2 Methodology

In the following statistical analysis we will address the features characteristic of the ownership structure of the bio-pharmaceutical sector. The analysis will make use of principal component analysis. The strength of the principal component analysis methodology in this connection is that its use does not require a theoretical model upon which the analysis is based. On the other hand, principal component analysis allows us to condense the information contained in the statistical data by using the joint variance of the variables. Principal component analysis is based on the assessment of correlations between selected variables and the mutually independent principal components.[8] The results of the principal component analysis are presented in appendix.

The use of principal component analysis is justified by the observation that the variables appearing in the model are mutually correlated. In regression analysis the correlation of the independent variables leads to a problem of multicollinearity, which may distort the results. For example, Tahvanainen (2003) encounters this problem when using regression analysis to evaluate the debt-equity ratio of SMEs in the biotech sector. In contrast, in the principal component analysis the variables are grouped into different principal components and one variable can be correlated with more than one principal component. Principal component transformations are indeed supposed to be carried out so that each variable is strongly correlated with only one principal component. Thus the variable regarded as the dependent variable can be kept in the principal component analysis as one of the variables. We can therefore evaluate separately the principal component that was correlated with the debt-equity ratio in Tahvanainen (2003).

In the next section the principal components are distinguished according to whether the correlation between the selected variable and the principal component is over 0.3, which

[8] E.g. Sharma (1996) provides a detailed technical presentation of principal component analysis.

corresponds roughly to the correlation level that differs from zero taking into account the sample size and assuming a normally distributed population.

In the next section presenting the results of the statistical analysis we name five principal components, the eigenvalues of which are greater than two. The strict method is necessitated by the fact that owing to the relatively large number of variables there are ten components with eigenvalues greater than one. In order to summarize the information contained in the data, we apply stricter criteria in the selection of the principal components. The analysis makes use of the rotation of principal components, based on the varimax method. The method seeks to produce a rotated final result where each variable is prominent in only one principal component. The rotated principal components analyzed explain slightly over half of the variance of the selected variables.

4.3 Results

The principal components are presented in six boxes in Figure 1. Principal component 2 is presented in two parts as components 2a and 2b, which are mirror images of each other. The interpretation of the components is based on the finance literature, which we extend upon in the study. This allows us to link our approach to one of the relevant bodies of corporate finance literature.

According to the pecking order theory, the quality of companies' development projects affects capital structures in two main ways. First, because the personnel working inside the company know more about the real return expectations than foreign owners, in high quality companies (high expected return projects) the ownership share of persons actively engaged in the business is high. This means that in the first stage only loan financing is raised outside the firm. Only when the loan financing runs out does the company raise external equity financing. On the other hand, external investors can gauge the quality of the company according to either the average quality prevailing in the sector or the company's intellectual capital. Below we will analyze the principal components both with respect to the "average quality" of the sector as well as the connection between the company's intellectual capital and capital structure.

The original pecking order theory expects that in high quality projects the first external financing comes from loans, not equity financing (Myers and Majluf 1984; Myers 1984). In the biotech sector high quality can mean e.g. R&D-intensive activities. Nevertheless as a company's research intensity grows, so does the information asymmetry between the company's personnel and external investors. Thus, for example, the risk premium on loan financing may become surprisingly large. Hyytinen and Pajarinen (2002) maintain that in this kind of situation a reversed pecking-order may be the best model for an R&D-intense company in practice because an R&D-intense SME has difficulties in getting loan financing. Thus financing in the form of loans precedes financing via external equity and capital loans.

The reversed pecking order seems to appear in some of the features of the "Big and Beautiful" principal components. This principal component also features a high volume of R&D activity, a high number of employees with doctorate degrees and ownership of considerable intangible assets. The "Big and Beautiful" companies are typically owned by private venture capital firms, government institutions and persons actively engaged in the company. This principal component is strongly correlated with variables depicting company size. The companies characterizing this principal component have a lot of

personnel and tangible assets. Baysinger, Kosnik and Turk (1991) find for US data on large enterprises that a high equity stake held by institutional investors increases the companies' expenditures on R&D activities. Thus the information included in the "Big and Beautiful" component is consistent with the above-mentioned study regarding the phenomenon that greater ownership by private venture capital firms and government institutions goes hand in hand with companies' R&D expenditures.

In the second principal component called "Promising Subsidiaries", a prominent role is played by equity financing from non-finance companies. For the companies of this principal component it is typical that they are already generating sales and that they expect their sales will be on a high level in five years. A considerable portion of the sales of these relatively older companies is directed abroad and they engage in collaboration with their clients. These efficient companies with growth expectations have a large international accounting company acting as their auditor. According to this principal component, the involvement of another company helps in the commercialization of products. On the other hand, it may be that other companies seek ownership in companies that have already been able to commercialize their products and services. In addition, this type of company has a higher portion of loan financing than other companies. According to Harris and Raviv (1990) the high prominence of loan financing and tangible assets reflects the real state of the company. On the one hand, a company that can service its debt conveys a message about its ability to perform to investors. On the other hand, if the company goes bankrupt it is easier to liquidate tangible assets than intangible ones, which reduces the risk to lenders of getting their money back.

"Doctors in Turku" is an "inverse component" with respect to the preceding principal component. This means that the component is the same, but they are mirror images of each other. As the name indicates, in this type of relatively young company many of the owners are doctors and the activities are often located in Turku. The biggest owners are private venture capital companies, government institutions and persons actively engaged in the business. A prominent feature of their capital structure is the small share of loan financing. This group thus seems to be characterized by the reversed pecking order.

The "Sound Business Plan" principal component includes companies with particular emphasis on R&D activities, a large portion of which has been financed by the public sector. These companies have a large number of employees with doctorate degrees. The company has protected its expertise with patents. Their sales are directed primarily abroad, and their marketing plans are based on foreign trade also in the future. The managing directors of these companies have long business careers behind them. In other words, the companies' business plans are based on prolonged experience in business: the personnel with a high level of education carries out R&D work, the results of which are protected via patents and growth is sought from international markets.

Cooperation between TEKES and SITRA in financing the activities of biotech companies is seen in the "TEKES and SITRA Collaboration" principal component. The companies fitting the characteristics of this principal component have received capital loans from the public sector as the companies have an experienced managing director. On the one hand, the track record of the management means something in the financing decisions of government institutions. On the other hand the collaboration between TEKES and SITRA is not characterized by a certain type of ownership structure or, for example, certain growth expectations of the company seeking financing, but rather these government institutions have engaged in cooperation in very diverse projects. This indicates

that collaboration between the institutions enhances their monitoring ability. It is efficient for many financiers to monitor simultaneously the quality of companies' projects.

Figure 1. Principal components numbered according to rotated component matrix (appendix).

1. "Big and beautiful"
- large personnel
- many employees with doctorates
- lots of tangible assets (machinery & equipment)
- many patents and patent applications
- high R&D expenditures and considerable governmental support for R&D activities
- R&D collaboration with foreign research institutes
- collaboration with subcontractors
- exports' share of turnover high in 5 years
- owners are private venture capital companies, government institutions and persons engaged in the business
- TEKES has provided financing

2.a "Promising subsidiaries"
- high sales expectations in future
- realized sales on high level
- exports' share of turnover is high
- owned by other non-financial companies
- R&D collaboration with customers
- audited by international accounting firm
- relatively old company
- TEKES has provided financing

- small ownership by private venture capital companies, government institutions and persons actively engaged in business
- few employees with doctorates
- relatively high share of loan financing
- located somewhere else than Turku

2.b "Doctors in Turku"
- owned by private venture capital companies, government institutions and persons actively engaged in business
- many employees with doctorates
- relatively low share of loan financing
- located in Turku
- relatively old company

- low sales expectations in 5 years
- realized sales on low level
- low share of sales are exported
- not owned by other non-financial companies
- no R&D collaboration with customers
- not audited by big 5 accounting firm

3. "Sound business plan"
- high R&D intensity
- high R&D expenditures and considerable public support for R&D activities
- many employees with doctorates
- exports' share of turnover is high
- exports' share of turnover high in 5 years
- many patents and patent applications
- experienced managing director

4. "TEKES and SITRA collaboration"
- TEKES and SITRA have provided financing
- lots of capital loans from government institutions
- experienced managing director

- no R&D collaboration with customers

5. "Experts Sought for International Collaboration"
- problems in obtaining skilled labour
- considerable government support for R&D expenditures
- exports' share of turnover high in 5 years
- R&D collaboration with foreign research institutions
- realized sales on low level

In the component called "Experts Sought for International Collaboration" some companies have had problems in obtaining skilled labour. These companies have obtained a great deal of financing for R&D from the public sector. The companies are engaged in international research projects with foreign research institutes. Even though they do not have a high turnover, they plan to commercialize their products or services and export them abroad within five years.

5. Discussion and Conclusions

This study analyses the capital structure of biotech companies that develop pharmaceutical products. The financing received from the company's investors is usually equity financing and to a lesser extent capital loans, i.e. subordinated loans on equity terms. On the other hand, ordinary loan financing is not a very popular form of financing in the bio-pharmaceutical sector.

The classic pecking order theory by Myers and Majluf (1984) does not appear to explain the forms of financing prevalent in the Finnish bio-pharmaceutical sector. The pecking order theory predicts that external equity financing is too expensive for R&D-intensive start-ups. According to this theory, external equity financing would be available on unfavourable terms. Thus entrepreneurs, i.e. the persons actively engaged in the business, fund the project themselves. After this the company can take a risk-free or low-risk loan and only after this is equity financing sought from external investors. In the Finnish bio-pharmaceutical sector, external financiers such as private venture capital firms and government institutions are participating as owners of the company in a rather early stage.

Bhagat and Welch (1995), Hall (2002) as well as Hyytinen and Pajarinen (2002) showed that SMEs are less dependent on loan financing the more R&D intensive their activities are. This decision gains partial support in the descriptive principal component analysis, but this phenomenon can be observed in certain individual bio-pharmaceutical companies. Many older bio-pharmaceutical companies owned by other companies have relatively low R&D intensity and solidity ratios. Furthermore, the reversed pecking order theory predicts high shares for external equity and capital loan financing and low shares of loan financing in young but relatively large R&D-intensive companies.

Ang, Cole and Wuh Lin (2000) observed that the owners' cost of monitoring the management of the company grows when the number of foreign investors increases and the ownership share of the management decreases. The management knows more about the situation of the company than outside investors. This empirical observation by Ang, Cole and Wuh Lin (2000) regarding the asymmetry with respect to the cost of information based on the principal – agent theory supports the hypothesis that the management's share of ownership is comparatively important in companies with many different owners. On the other hand, this also explains the relatively large share of bank loans in bio-pharmaceutical companies owned mainly by other companies. Banks are able to lower the costs stemming from the asymmetry of information costs between the owners and the management by monitoring the company with its own resources. The willingness to provide a loan gives the owners a signal about the sound shape of the company and thus reduces the cost of gathering information.

The "Big and Beautiful" principal component is marked by the following phenomenon: the more a company has intellectual property rights and R&D activity, the greater are its financial resources. This observation corresponds with the findings of Lerner and Merges (1998) obtained using international data. The more financial resources a company has, the more influence a company engaged in R&D collaboration has over decisions (e.g. about intellectual property rights).

Lerner, Shane and Tsai (2002) studied the equity financing cycles prevailing in the US biotechnology industry. According to them, companies seeking to finance their R&D activities are obliged to settle for partnership agreements on unfavourable terms when the stock market is in a slump. These kinds of partnership agreements appear to be difficult to change when the situation in the stock market improves. In future studies it would be worthwhile to analyze at what stage do the non-financial companies obtain stakes in biotech companies that are already generating revenues.

In the current situation prevailing in the financial markets, obtaining a listing on the stock exchange does not seem a realistic option. The licensing and royalty payments as well as mergers and acquisitions are the most common way of securing second round financing for commercialization projects. Thus technological expertise does not appear to suffice alone to achieve commercial success, but rather the start-up needs to engage in close-knit collaboration with another company and to invest in marketing know-how.

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Appendix. Results of Principal Component Analysis.

Communalities

	Variable	Initial	Extraction
SOURCES OF FINANCE			
Capital structure	Solidity (equity per total debt & equity)	1	0.6863903
Equity finance			
Equity finance from individuals active in business (log euros)	LNACTIV€	1	0.8010382
Equity finance from other non-financial firms (log euros)	LNFIRM€	1	0.838017
Equity finance from government institution (log euros)	LNPUBVC€	1	0.9035721
Equity finance from private venture capital organization (log euros)	LNPRVC€	1	0.8556579
Capital loan finance from government institution (log euros)	LNPUVCL€	1	0.8724937
Capital loan finance from private venture capital organization (log euros)	LNPRVCL€	1	0.7909272
INTANGIBLE ASSETS			
Human capital			
Number of personnel	LNPERSON	1	0.9271824
Number of doctors on staff	LNDOCS	1	0.8224857
CEO's experience (in years)	LNCEOEXP	1	0.8187757
CEO is a doctor (=1)	post-graduated CEO	1	0.7225567
Structural capital			
Research and development (R&D) costs (log euros)	LNRDCOST	1	0.9164357
Number of patents and patent applications (log)	LNPATENT	1	0.8928357
Age of firm (log years)	LNAGET	1	0.7991473
Patent per number of personnel	Patents / total personnel	1	0.8508303
R&D costs per total costs	r&d costs per total costs	1	0.8566066
Relational capital			
Public support to R&D activities (log euros)	LNPBRD	1	0.9210542
Problems in skilled labour supply (=1)	Problems in skilled labour supply	1	0.7373992
SITRA has financed a firm (=1)	SITRA has financed a firm	1	0.7982579
TEKES has financed a firm (=1)	TEKES has financed a firm	1	0.8500641
Public supports to R&D activities per R&D costs	public r&d support per r&d costs	1	0.8427616
Firm has top-5 auditor (=1)	Top5 Auditor	1	0.7072709
Collaboration with foreign academic institutions (=1)	collaboration with foreign academic institutions	1	0.7907651
Principal customer's share of total sales over 1/3	principal customer (>1/3)	1	0.660605
Principal subcontractor's share of total purchases over 1/3	principal subcontractor (>1/3 out of purchases)	1	0.7711855
R&D collaboration with customers	rd collaboration with customers	1	0.7862258
R&D collaboration with subcontractors	rd collaboration with subcontractors	1	0.6515332
TANGIBLE ASSETS			
Tangible assets (log euros)	LNTANG	1	0.8908755
BACKGROUND DUMMIES			
Location in Turku region	Turku	1	0.7502396
Firm announces its core branch in pharmaceutical industry	Pharma=1	1	0.8309156
Firm has spun out from academic research	research spin-off	1	0.8221582
BUSINESS PERFORMANCE			
Present turnover			
Turnover (log euros)	LNTO	1	0.8679751
Exports per turnover	exports per turnover	1	0.7579612
Anticipated future turnover			
Anticipated future turnover in 2006	LNTO5	1	0.8479678
Exports per turnover in 5 yrs	exports per turnover in 5 yrs	1	0.7962595

Extraction Method: Principal Component Analysis.

Appendix, cont.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.5500655	21.571616	21.571616	7.5500655	21.571616	21.571616	5.155834	14.730954	14.730954
2	5.3737336	15.353525	36.92514	5.3737336	15.353525	36.92514	4.6588054	13.310872	28.041827
3	2.94936	8.4267429	45.351883	2.94936	8.4267429	45.351883	2.9549013	8.4425752	36.484402
4	2.49134	7.1181144	52.469997	2.49134	7.1181144	52.469997	2.6240589	7.4973112	43.981713
5	2.3085172	6.5957633	59.065761	2.3085172	6.5957633	59.065761	2.4885319	7.1100911	51.091804
6	1.8265491	5.2187116	64.284472	1.8265491	5.2187116	64.284472	2.4314193	6.9469122	58.038717
7	1.713833	4.8966657	69.181138	1.713833	4.8966657	69.181138	2.1736823	6.2105208	64.249237
8	1.5897537	4.5421534	73.723292	1.5897537	4.5421534	73.723292	2.0816619	5.9476053	70.196843
9	1.3767422	3.9335492	77.656841	1.3767422	3.9335492	77.656841	1.9519456	5.5769874	75.77383
10	1.256533	3.5900944	81.246935	1.256533	3.5900944	81.246935	1.9155867	5.4731049	81.246935
11	0.9546938	2.7276966	83.974632						
12	0.8947182	2.5563376	86.530969						
13	0.7623783	2.1782236	88.709193						
14	0.6166829	1.7619513	90.471144						
15	0.5806536	1.6590104	92.130155						
16	0.485015	1.3857572	93.515912						
17	0.4084618	1.1670338	94.682946						
18	0.3978799	1.1367997	95.819745						
19	0.3459201	0.9883432	96.808088						
20	0.2866466	0.8189902	97.627079						
21	0.2544	0.7268571	98.353936						
22	0.1755862	0.5016749	98.855611						
23	0.1269336	0.3626674	99.218278						
24	0.0909274	0.2597925	99.478071						
25	0.0701375	0.2003928	99.678463						
26	0.0523641	0.1496117	99.828075						
27	0.0361161	0.1031889	99.931264						
28	0.0240576	0.068736	100						
29	4.334E-16	1.238E-15	100						
30	1.693E-16	4.838E-16	100						
31	1.253E-16	3.58E-16	100						
32	5.48E-17	1.566E-16	100						
33	-1.423E-16	-4.064E-16	100						
34	-3.858E-16	-1.102E-15	100						
35	-5.117E-16	-1.462E-15	100						

Extraction Method: Principal Component Analysis.

Appendix, cont.

Component Matrix(a)

	Component									
	1	2	3	4	5	6	7	8	9	10
LNPBRD	**0.835376**	0.0252071	-0.2069432	0.2053087	-0.070921	0.1636177	-0.0939433	0.2266713	-0.185606	-0.1055139
LNPERSON	**0.7879374**	0.2794558	0.1143391	-0.2723011	-0.2206523	0.0715007	-0.1096641	-0.1289529	-0.2416936	-0.0122283
LNRDCOST	**0.7759517**	0.1031488	0.1089786	**0.3185527**	-0.1969846	**0.3173479**	-0.1802982	0.0204263	-0.0809058	0.1065824
LNTANG	**0.7202918**	**0.4721778**	0.1247984	-0.0386221	-0.1927352	-0.1965564	0.0007183	0.2001652	-0.0306558	0.1234882
exports per turnover in 5 yrs	**0.7163789**	0.0215664	-0.1772552	0.1610748	**0.4120551**	0.1806152	0.1025551	-0.0709282	0.0662257	0.0537179
LNPRVC€	**0.6647698**	-0.1850622	0.2686114	0.1372457	-0.329148	-0.0821671	0.2533517	-0.069659	-0.0561944	**-0.3181437**
Pharma=1	**0.664488**	0.1729131	0.0517115	-0.298995	0.1082562	**0.3099998**	0.0887926	-0.166412	**0.3497015**	0.041387
LNPATENT	**0.6620579**	0.027499	**0.3243345**	**0.4140451**	**0.3715953**	-0.1045055	-0.1411523	0.0551501	-0.0622035	0.0359632
LNPUBVC€	**0.6367867**	**-0.5238026**	**0.3248937**	-0.2624533	-0.1976269	-0.074481	0.0182423	-0.0005234	-0.0647269	0.0118982
TEKES has financed a firm	**0.6028728**	0.2934693	**-0.4023608**	-0.2034334	-0.2321291	-0.2284507	-0.2918567	0.0468323	0.0164862	-0.059041
collaboration with foreign academic institutions	**0.5982522**	-0.2007331	0.270147	-0.227369	0.2343139	-0.0785412	0.251482	0.0940137	**-0.3058899**	-0.2028977
LNDOCS	**0.5716328**	**-0.4507345**	-0.0152973	-0.0254594	-0.1445188	0.2939711	0.2747969	-0.1340867	-0.0361689	0.2992867
principal customer (>1/3)	**-0.4821565**	0.079205	-0.1479131	0.2873072	-0.1990086	0.0786958	**0.3999769**	0.1238526	0.223197	0.2156329
Top5 Auditor	**0.4693151**	0.1864997	0.0658002	**-0.4660462**	0.085417	0.0794999	0.0710998	**0.3245882**	0.2461685	0.2146519
rd collaboration with customers	**-0.4453923**	**0.4349214**	**0.4031327**	-0.1258584	-0.1247647	0.3322012	0.1989025	0.0112225	-0.1535042	-0.1765303
LNFIRM€	0.1168886	**0.8314251**	-0.0617772	-0.2159564	-0.0797035	0.0527135	-0.2398101	0.1262628	0.0044691	0.005504
LNTO	-0.1397957	**0.8238015**	0.3038595	0.0547549	-0.0879529	-0.170912	-0.0755769	0.1280682	-0.1037487	0.0680508
LNTO5	-0.0498077	**0.8015217**	0.171901	-0.0200594	-0.0012865	-0.030703	-0.0248733	0.2461485	-0.1270213	0.307914
Solidity (equity+caploans per equity+debt)	-0.0932296	**-0.6076626**	0.1421402	0.0190996	**0.3914056**	0.0042876	-0.1350439	0.0566011	-0.1674337	0.2918642
exports per turnover	0.1979669	**0.600224**	-0.0250352	0.1656018	**0.4533727**	0.2450149	0.1930316	-0.0704757	-0.0121435	0.149987
LNAGET	**0.4011932**	**0.5650278**	-0.086716	**0.3083616**	0.1486892	-0.2353651	0.1784457	-0.2292884	0.010929	-0.2329972
Turku	-0.0649344	**-0.5416871**	**0.4156239**	0.2654928	0.0234006	0.0037162	-0.2023419	0.39512	0.0571787	-0.0920635
Patents / total personnel	0.083628	-0.0702626	**0.6226724**	0.1606211	**0.4523547**	-0.2815908	0.0171916	-0.0720497	**0.3380963**	-0.1471932
public r&d support per r&d costs	0.277179	-0.118166	**-0.5765545**	-0.108299	**0.4580709**	-0.1073287	0.2360473	0.1670207	0.041851	**-0.3179817**
rd collaboration with subcontractors	0.2943375	0.0855758	**0.4879632**	-0.080664	0.1636947	0.2297912	**-0.3300587**	0.0207895	0.2556993	-0.2420902
LNPUVCL€	**0.4031676**	-0.16951	**-0.4600136**	**-0.4152867**	-0.0963217	**-0.3454972**	-0.1796908	-0.1311583	**0.3032186**	0.1645031
LNCEOEXP	**0.3772668**	0.1353715	-0.2036257	**0.6224144**	0.0757296	-0.409694	-0.1574782	-0.0104657	0.1740758	0.0214843
r&d costs per total costs	**0.3788936**	-0.2948607	-0.2396302	**0.4707054**	-0.0914218	**0.3929414**	-0.1629073	-0.0634095	**0.3003204**	0.2521991
LNACTIV€	0.2982501	-0.494674	-0.0731743	0.2816268	**-0.5705111**	0.069478	0.0366376	0.0065268	-0.1662174	-0.1529424
Problems in skilled labour supply	0.1372081	-0.2096243	**-0.4168142**	**-0.3987663**	**0.4441255**	0.2608603	-0.0352393	0.0232762	-0.1998419	-0.1867252
SITRA has financed a firm	0.2893369	-0.3762562	0.1851437	-0.2175391	-0.0552852	**-0.6349818**	0.1367405	-0.0392827	-0.0119025	0.2544223
principal subcontractor (>1/3 out of purchases)	-0.2665188	-0.2494189	-0.0557795	-0.1255829	-0.0624053	0.1173653	**-0.5855763**	**0.4014793**	0.2143348	-0.2266436
LNPRVCL€	0.0906612	0.27056	-0.1896088	0.0773904	**-0.3233272**	0.014803	**0.4332726**	0.2885319	**0.4294154**	**-0.3277673**
research spin-off	0.0166507	-0.0577288	**-0.4153908**	0.2546267	0.1593404	-0.1004921	0.1028986	**0.6477881**	**-0.3309965**	0.0768097
post-graduated CEO	0.1791031	-0.2795362	**0.3235305**	-0.2171556	-0.0011761	0.043945	0.354817	**0.5098706**	0.222261	0.1526898

Extraction Method: Principal Component Analysis.

A 10 components extracted.

Appendix, cont.

Rotated Component Matrix(a)

	Component									
	1	2	3	4	5	6	7	8	9	10
LNPERSON	**0.832105**	0.2927441	0.1322656	0.180942	0.0462707	-0.1308048	0.0440874	0.0070351	0.1437658	-0.238616
LNPRVC€	**0.7291953**	**-0.3422608**	0.0792421	0.0064245	-0.1433218	0.1884379	0.0927141	0.3199159	0.175508	-0.0517098
LNPBRD	**0.7101219**	0.0501616	**0.5062112**	0.1233892	0.225571	-0.002955	-0.0012586	0.1455102	-0.0218343	0.2650426
LNPUBVC€	**0.6670803**	**-0.4215487**	0.020469	0.2328429	-0.0756838	0.067368	0.4044034	-0.1631527	-0.021218	-0.159249
collaboration with foreign academic institutions	**0.6567743**	-0.1521017	-0.1534355	-0.0386123	**0.3175246**	0.2453286	**0.3108132**	-0.1121465	0.1972234	0.0464505
LNTANG	**0.6246222**	**0.5027768**	0.1568919	0.2824646	-0.1366767	0.1098646	0.1902878	0.2139946	0.158399	0.0754496
principal customer (>1/3)	**-0.57591**	-0.040821	0.0843069	-0.1881027	-0.2728226	-0.1732368	0.1070723	0.305578	0.1828322	0.2050922
LNTO5	-0.006055	**0.864019**	-0.0464692	-0.1264676	-0.2136363	-0.0258714	0.0799704	0.0188733	0.126698	0.1188911
LNFIRM€	0.1428114	**0.8464874**	-0.0173129	0.0546188	0.0339195	-0.1441155	-0.1054838	0.2068893	-0.0905611	-0.1172471
LNTO	0.0291054	**0.79202**	-0.2188257	-0.171917	**-0.3374104**	0.1128627	-0.1133996	0.1310833	0.0677008	0.0343902
LNACTIV€	**0.4347158**	**-0.5968364**	0.2226056	0.0136435	-0.276302	-0.2360336	-0.0760071	0.1685198	-0.0785015	0.1836142
exports per turnover	-0.0411783	**0.5636498**	**0.3084346**	-0.2282227	0.2911241	0.1947704	-0.0299139	0.0272842	**0.4077601**	-0.0273975
r&d costs per total costs	0.0155806	-0.2737867	**0.8721311**	0.1137428	-0.0511727	-0.019355	-0.019818	0.0158407	-0.0649228	-0.0016541
LNRDCOST	**0.6625738**	0.1217836	**0.667052**	-0.0188419	-0.119805	0.0400348	0.0036206	0.0252775	0.0233005	-0.0116585
exports per turnover in 5 yrs	**0.3262775**	0.0422603	**0.5481452**	0.1334425	**0.4599682**	0.265756	0.072584	-0.0068137	0.2866655	0.007586
LNDOCS	**0.3737643**	**-0.4185263**	**0.452299**	0.0917618	0.0323151	-0.1930273	**0.369102**	-0.1238913	**0.3084555**	-0.0979447
LNPUVCL€	0.0957648	-0.0782173	0.051416	**0.871425**	0.1926413	-0.1574209	0.0848235	0.0380141	-0.0222846	-0.1554057
rd collaboration with customers	-0.0988364	**0.3205146**	**-0.3216521**	**-0.6730545**	-0.157989	-0.1502506	0.0307584	0.1322626	0.017216	-0.2258172
TEKES has financed a firm	**0.4804135**	**0.3164**	0.1268402	**0.6067572**	0.1458177	-0.1723796	-0.1465169	0.2320941	-0.0884225	0.0280044
SITRA has financed a firm	0.2277767	-0.2745604	-0.2896162	**0.5429067**	-0.2159746	0.2069765	0.3146271	-0.2103515	0.2323552	0.0752054
Problems in skilled labour supply	0.0682695	-0.1059925	-0.016068	0.03663	**0.7935515**	-0.203855	0.0225136	-0.2045395	-0.0791886	-0.0030356
public r&d support per r&d costs	0.0119703	-0.1388794	0.0049292	0.2532655	**0.7797234**	0.1012485	0.013735	0.2280527	0.0924603	0.283192
Patents / total personnel	-0.022539	-0.0549271	-0.110751	-0.0663038	-0.0724985	**0.8671487**	0.1419462	-0.0759983	0.0130615	-0.2175898
LNPATENT	**0.4857428**	0.108746	**0.3886552**	0.020334	0.026577	**0.651337**	0.0035202	-0.190605	0.1079503	0.1437197
LNCEOEXP	0.090693	0.0722876	**0.384487**	**0.3856561**	-0.1303531	**0.4596008**	**-0.3474778**	0.1888537	0.1079087	**0.335393**
post-graduated CEO	0.0816593	-0.1379678	-0.0219097	-0.0478006	-0.0347189	0.1257641	**0.8108388**	0.0799661	-0.0640511	0.0954442
Top5 Auditor	0.2383208	**0.3611944**	0.1064743	0.2526889	0.2135282	-0.0054789	**0.6101852**	0.071895	-0.0328619	-0.1436143
LNPRVCL€	-0.0366105	0.0500265	0.0405761	-0.006474	0.0095817	-0.0297627	0.1843589	**0.863081**	0.0174781	0.07222
Solidity (equity+caploans per equity+debt)	-0.1295055	**-0.3693148**	0.0521086	-0.0143842	0.0852078	0.1630511	0.1945555	**-0.6540476**	-0.0847032	0.1537927
principal subcontractor (>1/3 out of purchases)	-0.1552291	-0.0732395	-0.0232133	0.0431879	0.0461608	-0.0514284	0.0051391	-0.0359976	**-0.8558859**	0.0261279
Turku	0.0512032	**-0.3970463**	0.0541722	-0.2059953	-0.2337155	**0.3542439**	0.2311848	-0.1812437	**-0.4786035**	0.2216635
LNAGET	0.2536022	**0.3464313**	0.0975618	0.0790874	0.1188756	**0.3572686**	**-0.3592118**	**0.3764894**	**0.4309932**	0.027215
research spin-off	-0.0219012	0.0591175	0.0876454	-0.001883	0.2292833	-0.0873727	0.0910199	0.0066571	-0.0656426	**0.8588688**
Pharma=1	**0.3442345**	0.1808318	**0.3743293**	0.1663415	**0.3054103**	0.0694434	**0.3180964**	0.1564287	0.1566771	**-0.5134446**
rd collaboration with subcontractors	**0.2986942**	0.1568297	0.1381328	-0.1610257	0.0497592	**0.4044891**	0.1120648	-0.0251105	**-0.3591931**	**-0.4294338**

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 13 iterations.

Appendix, cont.

Component Transformation Matrix

Component	1	2	3	4	5	6	7	8	9	10
1	0.765137	0.0320552	0.4182002	0.3246962	0.185007	0.1786928	0.1698277	0.0863262	0.170267	-0.0421375
2	0.0041987	0.8961063	-0.0413413	-0.1074283	-0.036804	-0.0028326	-0.2072486	0.310354	0.1910855	-0.0811058
3	0.2510253	0.0512936	-0.2182918	-0.4258171	-0.474671	0.4777384	0.3123501	-0.2221041	-0.0531567	-0.3195603
4	-0.1009028	-0.1457236	0.5150882	-0.2530077	-0.3350404	0.3769598	-0.4109835	0.1339238	0.1150647	0.429908
5	-0.253488	0.1436023	0.0241452	-0.0893324	0.6552395	0.5479868	0.0291465	-0.3973281	0.1224651	0.0566903
6	-0.0052714	0.0039702	0.5298768	-0.6185944	0.2438627	-0.3808337	0.1289322	-0.0278712	-0.1533289	-0.301852
7	-0.0966353	-0.2193818	-0.161648	-0.2498701	0.0969588	-0.0375094	0.4021617	0.4030768	0.709077	0.1271416
8	0.0313192	0.2129071	-0.0161276	-0.097486	0.0476708	0.0217245	0.5248059	0.1678152	-0.480637	0.6376413
9	-0.4404811	-0.0381713	0.283704	0.319553	-0.0556658	0.3249916	0.2730393	0.4633235	-0.2121321	-0.4230602
10	-0.2696773	0.237797	0.3495738	0.270197	-0.3511029	-0.2119103	0.3640848	-0.5147954	0.3179943	0.0929881

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

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