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OWNERSHIP AND FINANCIAL STRUCTURE OF BIOTECHNOLOGY SMEs: EVIDENCE FROM FINLAND

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ABSTRACT: The aim of this study is to depict the ownership and financial structure of Finnish small and medium-sized biotechnology enterprises. Most of the firms are owned by several groups of owners. In small companies the largest share of equity is held by individuals active in the business. Private venture capitalist companies own the largest stakes in both large and infant companies, while the same holds for public venture capitalists in adolescent companies and other non-financial firms in middle-aged companies. The low profits in the Finnish biotechnology company, and hence the low level of equity was offset by raising high amounts of capital loans. The governmental institutions Tekes and Sitra are the largest capital loan suppliers. The debt ratio was 25% out of the total assets of the Finnish biotechnology firms. Trade credit, domestic banks and Tekes were the main sources of the debt finance.

Principal component analysis shows that equity investments from private venture capital (VC) companies were related to the loans from domestic, both private and public, financial institutions. This raises questions on monitoring aspects of investors. The high equity share of principal owners with significant influence in the board and the high equity share of individuals active in the business seems to keep public investments relatively moderate in the company. The high equity shares of private and public VCs are partially connected to high growth prospects of companies. In order to explain these relations it would be necessary to investigate any systematical features behind the anticipations.

KEYWORDS: biotechnology, corporate finance, financial structure, ownership structure, venture capital.

HERMANS, Raine – **TAHVANAINEN**, Antti-Jussi, **SUOMALAISTEN PIENTEN JA KESKISUURTEN BIOTEKNIIKKAYRITYSTEN OMISTUS- JA RAHOITUSRAKENNE.** Helsinki: ETLA, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 2002, 41 p. (Keskusteluaiheita, Discussion Papers, ISSN, 0781-6847; no. 835).

TIIVISTELMÄ: Tutkimuksen tavoitteena on kuvata suomalaisten pienten ja keskisuurten biotekniikkayritysten omistajuus- ja rahoitusrakenteita. Useimmilla yrityksillä on monia omistajaryhmiä. Liiketoiminnassa aktiivisesti mukana toimivat yksityishenkilöt omistavat suurimman osan pienistä biotekniikka-alan pk-yrityksistä. Yksityiset pääomasijoitusyhtiöt omistavat suurimman osuuden sekä suurista että nuorimmista yrityksistä. Julkiset pääomasijoitusinstituutiot omistavat suurimman osan kasvuikäisistä yrityksistä ja muut ei-rahoitusalan yritykset keskiikäisistä yrityksistä. Suomen biotekniikkayritysten alhaiset voitot, ja täten myös oman pääoman tasearvon alentuminen, kompensoitiin ottamalla huomattavia määriä pääomalainaa. Julkiset instituutiot, Tekes ja Sitra ovat suurimmat pääomalainan tarjoajat. Velkaantumisaste oli 25 prosenttia suomalaisten biotekniikka-alan pk-yritysten rahoituksen kokonaisarvosta. Ostovelat muille yrityksille, kotimaiset pankit ja Tekes olivat lainarahoituksen päälähteitä.

Pääkomponenttianalyysi osoittaa, että yksityisten pääomasijoitusyhtiöiden omistusosuus oli yhteydessä kotimaisten, sekä yksityisten että julkisten, rahoitusinstituutioiden lainanantoon. Tämä nostaa esiin kysymyksiä sijoittajien monitorointitavoista. Julkisten instituutioiden sijoitukset näyttävät pysyvän joiltain osin vähäisenä sellaisissa yrityksissä, joiden vaikutusvaltaiset pääomistajat tai liiketoimintaan osallistuvat yksityishenkilöt omistavat suuren osan yrityksestä. Yksityisten ja julkisten pääomasijoitusinstituutioiden omistusosuus näyttää liittyvän osittain yritysten suuriin kasvuodotuksiin, minkä selvittämiseksi olisi tarpeellista tutkia odotusten taustalla olevia systemaattisia piirteitä.

ASIASANAT: bioteknologia, yritysrahoitus, rahoitusrakenne, omistajuusrakenne, pääomasijoittaminen

Suomenkielinen yhteenveto

Raine Hermans – Antti-Jussi Tahvanainen

Suomalaisten pienten ja keskisuurten biotekniikkayritysten omistus- ja rahoitusrakenne

- **Nuorten biotekniikkayritysten tuotteiden kaupallistaminen on vielä alussa.**
- **Biotekniikkayritykset ovat tutkimusintensiivisiä, ja tuottoja odotetaan yleensä vasta tulevina vuosina.**
- **Odotettujen tuottojen saaminen edellyttää huomattavia pääomapanostuksia tämänhetkiseen toimintaan.**
- **Biotekniikkayritysten pääomapanostukset ovat valtaosin osake- ja pääomalainarahoitusta. Siksi pienet ja keskisuuret biotekniikkayritykset ovat velattomampia kuin suomalaiset pk-yritykset keskimäärin.**
- **Bioyritysten suurimmat omistajaryhmät ovat yksityiset pääomasijoitusyhtiöt, bioyritysten liiketoiminnassa aktiiviset henkilöt, muut ei-rahoitusalan yritykset ja julkiset pääomasijoitusinstituutiot (pääosin Sitra).**
- **Yli puolet pääomalainoista on tullut Tekesistä. Myös yksityiset pääomasijoitusyhtiöt ja Sitra ovat olleet aktiivisia pääomalainan tarjoajia.**
- **Pääomalainat ovat turvanneet rahoituksellinen omavaraisuuden ja toiminnan jatkumisen huomattavista tappioista huolimatta.**
- **Merkittävimpiä lainanantajina ovat muut ei-rahoitusalan yritykset, kotimaiset rahoituslaitokset ja Tekes.**

Biotekniikkayritysten tutkimusintensiivisyys edellyttää suuria pääomapanostuksia

Suomessa toimi vuoden 2001 lopussa hieman yli 100 pientä tai keskisuurta (pk) biotekniikka-alan yritystä. Yrityksissä kehitetään esimerkiksi lääke-, diagnostiikka-, biomateriaali- ja elintarvikealojen tuotteita ja palveluja. Lisäksi alan tuotteita voidaan käyttää osana prosessiteollisuuden arvoketjua. Monien nuorten biotekniikkayritysten tuotteiden kaupallistaminen on vielä alkuvaiheissaan. Alan pk-yritysten liikevaihto oli viime vuoden lopussa yhteensä runsaat 140 miljoonaa euroa.

Toiminta on tutkimusintensiivistä ja tuottojen odotetaan toteutuvan yleensä vasta tulevina vuosina. Biotekniikka-alan pk-yritykset käyttävät tutkimus- ja kehitystoimintaan vuodessa yli 110 miljoonaa euroa.

Lähivuosina yritykset odottavat liikevaihtonsa moninkertaistuvan. Kuitenkin tulevaisuuden tuotto-odotusten toteutuminen edellyttää huomattavia pääomapanostuksia tämänhetkiseen toimintaan.

Biotekniikkayritykset ovat vähävelkaisia verrattuna muuhun pk-sektoriin

Biotekniikkayritysten oman ja vieraan pääoman yhteisarvo oli vuoden 2001 lopussa noin 305 miljoonaa euroa. Tasearvosta 44 prosenttia oli osakerahoitusta ja jakamat-

tomia voittoja (ja myös tappioita). 32 prosenttia kokonaisrahoituksesta oli oman pääoman ehtoista pääomalainaa ja 25 prosenttia vieraan pääoman ehtoista lainaa.

Biotekniikkayritysten velkaantumisaste jäi noin 25 prosenttiin, kun kaikkien toimialojen pk-yrityksillä keskimäärin yli 50 prosenttia toiminnasta rahoitetaan velalla. Monet kasvuhakuiset nuoret tutkimusintensiiviset yritykset ovat saaneet suhteellisen paljon lainavaroja julkiselta sektorilta.

Pääomalainoilla on huomattava merkitys rahoituksellisen omavaraisuuden turvaamisessa

Pääomalainat ovat turvanneet rahoituksellinen omavaraisuuden ja toiminnan jatkumisen huomattavista tappioista huolimatta. Biotekniikka-alan pk-yritysten tappiot olivat vajaat 100 miljoonaa euroa pelkästään vuonna 2001.

Huomattavat tappiot syövät yritysten omaa pääomaa ennen kuin tuotteita ja palveluja onnistutaan kaupallistamaan. Kuitenkin yhteensä lähes 100 miljoonan euron pääomalainat helpottavat yritysten rahoitusasemaa ja vähentävät konkurssiriskiä, koska ne ovat lainaluonteesta huolimatta osa omaa pääomaa. Yli puolet alan pk-yritysten pääomalainoista on tullut Tekesistä.

Biotekniikkayrityksillä on monenlaisia omistajia

Omistajien nimellinen varallisuus yritysten taseissa oli vuoden 2001 lopussa reilut 130 miljoonaa euroa. Omistajien varallisuus ylitti laskennallisesti yli 210 miljoonaan euroa, kun sitä korjattiin siten, että kaikki omistusosuudet voitiin kuvata positiivisina lukuina. Korjatusta omasta pääomasta yksityishenkilöiden osuus oli runsas neljännes, yksityisten pääomasijoitusyhtiöiden vajaa neljännes, muiden ei-rahoitusalan yritysten runsas viidennes, julkisen pääomasijoittajan (pääosin Sitra) vajaa viidennes ja muiden sijoittajien noin 6 %.

Liiketoiminnassa mukana olevat yksityishenkilöt omistivat liikevaihdoltaan pieniä yrityksiä, joiden työntekijät olivat suurelta osin tutkijakoulutettuja, eli tohtoreita tai lisensiaatteja. Muut ei-rahoitusalan yritykset olivat sellaisten yritysten omistajina, joilla oli jo syntynyt liikevaihtoa ja jotka eivät olleet nuorimpien yritysten joukossa.

Liiketoiminnassa on näkyvissä joitain yleisiä, ei-omistajasidonnaisia piirteitä

Kokeneen johdon merkitys näyttää korostuvan henkilöstöltään suurissa yrityksissä, kun yritykselle alkaa syntyä liikevaihtoa ja erityisesti vientiä. Kokenut toimitusjohtaja näyttää arvostavan yrityksen ulkopuolista akateemista tutkimusyhteistyötä. Myös julkiset tutkimustuet liittyvät yrityksen ja akateemisen tutkimusinstituution väliseen yhteistyöpanostuksiin. Lisäksi julkista tutkimustukea vastaanottavissa yrityksissä vaikutusvallaltaan merkittävien sijoittajien omistusosuus on vähäinen.

Pääomasijoittajan suuri omistusosuus yrityksessä liittyy suuriin kasvuodotuksiin

Monet nuoret ja liikevaihdoltaan pienet biotekniikkayritykset ovat verraten tutkimusintensiivisiä, mikä osaltaan selittää liiketoiminnan huomattavia kasvuodotuksia tulevaisuudessa. Yksityiset pääomasijoitusyhtiöt omistavat huomattavia osuuksia näistä tutkimusintensiivisimmistä yrityksistä. Kuitenkin sekä yksityiset että julkiset pääomasijoitusinstituutiot omistavat merkittävän osan myös sellaisista yrityksistä, joilla on

suuret tulevaisuuden kasvuodotukset ilman merkittäviä eroja tutkimus- tai innovaatiointensiivisyydessä.

Suuret kasvuodotukset pääomasijoittajaomisteisissa yhtiöissä saattavat johtua toisaalta siitä, että pääomasijoitusinstituutioilla on muita sijoittajia parempi kyky monitoroida yritysten kasvuodotuksiin vaikuttavia tekijöitä. Toisaalta huomattavat kasvuodotukset saattavat liittyä pääomasijoittajainstituutioiden asettamiin kasvuvaatimuksiin, jolloin yrityksen on tämän vaihtoehdon mukaan esitettävä muita yrityksiä suurempia kasvuennusteita turvatakseen rahoituksen saannin.

Jatkotutkimus yritysten kasvuodotusten asettamisesta on tärkeää yritysten tämänhetkisen arvon määrittämiseksi ja toimialan kasvuvaikutusten ennakoimiseksi. Yritysten arvon määritys ja kasvuvaikutusten ennakointi on osaltaan tärkeätä esimerkiksi sen selvittämiseksi, miten biotekniikka-alan rahoittajat kohdentavat varojaan koko toimialalla.

Tutkimuksen tausta

Tutkimus tarkastelee pienten ja keskisuurten (pk) biotekniikkayritysten omistus- ja rahoitusrakenteita Suomessa vuoden 2001 lopussa. ETLAn keräämään yritysaineistoon kuuluu 72 Suomessa toimivaa pk-yritystä. Kun kaikkiaan biotekniikkaan erikoistuneita pk-yrityksiä oli vuoden 2001 lopussa reilut 100, otosta voidaan pitää hyvin perusjoukkoa edustavana.

Esitettävät muuttujat, kuten rahoitusosuudet prosentteina tai koko alan yhteenlasketuina euromääräisinä arvoina, ovat yritysten iän mukaan painotettuja arvioita. Menettelyn taustalla on oletus siitä, että otoksen ulkopuolelle jääneet yritykset ovat rahoitusrakenteiltaan keskimäärin samankaltaisia kuin vastaavan ikäiset otoksessa mukana olevat yritykset.

Kyselyn pohja-aineistona toimi Suomen bioteollisuus ry:n yritysrekisteri. Tutkimuksen on rahoittanut TEKES ja se on osa tutkimusprojektia ”Bioteknologia osana kansallista innovaatiojärjestelmää”.

Suomenkielisen yhteenvedon Liite 1.

Vertailu Suomen biotekniikkaa-alan pienten ja keskisuurten (pk) yritysten ja kaikkien suomalaisten pk-yritysten välillä.*

		Biotekniikka-alan pk-yritykset ETLAn kyselyssä		Kaikki suomalaiset pk-yritykset**
		Luku-määrä	%	%
Liikevaihto, miljoonaa euroa	< 0.2	36	50 %	15 %
	0.2-1.5	23	32 %	56 %
	1.6-8.0	8	11 %	24 %
	>8	5	7 %	5 %
Työntekijöiden lukumäärä	<5	31	43 %	44 %
	5-20	21	29 %	41 %
	>20	20	28 %	15 %
Yrityksen ikä	0-2	11	15 %	5 %
	3-4	13	18 %	9 %
	5-24	48	67 %	70 %
	>24	0	0 %	16 %
Vienti / liikevaihto	0 %	27	38 %	70 %
	0-1 %	1	1 %	22 %
	2-5 %	6	8 %	4 %
	6-10 %	1	1 %	2 %
	>10 %	37	51 %	3 %
	N/A	1	1 %	0 %
Tutkimus- ja kehittämismenot / kokonaiskustannukset (Kaikki Suomen yritykset: tutkimus- ja kehittämismenot / liikevaihto)	0 %	8	11 %	53 %
	0-1 %	2	3 %	23 %
	2-5 %	2	3 %	13 %
	6-10 %	3	4 %	3 %
	>10%	55	76 %	6 %
	N/A	2	3 %	0 %
Yritysten odottama liikevaihdon vuosikasvu seuraavan 5 viiden vuoden aikana (kaikilla yrityksillä seuraavan 3 vuoden aikana)	<0 %	0	0 %	1 %
	0-1 %	4	6 %	31 %
	2-5 %	0	0 %	20 %
	6-10 %	7	10 %	23 %
	>10 %	59	82 %	21 %
	N/A	2	3 %	5 %
Yrityksellä on patentteja	Kyllä	45	63 %	6 %
	Ei	27	37 %	94 %
Havaintojen lukumäärä		72	100 %	754

* Yritys on pieni tai keskisuuri, kun seuraavista kolmesta ehdosta kaksi täyttyy:
1 Yrityksellä on korkeintaan 250 työntekijää
2 Yrityksen liikevaihto on enintään 40 miljoonaa euroa
3 Yrityksen taseen loppusumma on enintään 27 miljoonaa euroa.

** Hyytinen, Ari –Pajarinen, Mika (2002): Small Business Finance in Finland – A Descriptive Study. Discussion paper no. 812, 44 pages. ETLA - The Research Institute of the Finnish Economy, Helsinki. Hyytinen ja Pajarinen painottavat toimialoittain aineistoaan kuvatakseen koko Suomen pk-sektoria.

Suomenkielisen yhteenvedon Liite 2.

Suomen biotekniikka-alan pk-yritysten rahoitusrakenne

Oma ja vieras pääoma				
	Oma pääoma ilman pää-omalainoja	Pääomalainat	Vieras pääoma	Yhteensä
%	43.6 %	31.5 %	24.9 %	100.0 %
Yhteensä, miljoonaa euroa				305.3

Oman pääoman (ilman pääomalainoja) jakauma rahoituslähteittäin								
	Henkilöt		Yhteisöt					
	Liike-toiminnassa aktiiviset henkilöt	Muut henkilöt	Julkinen pääoma-sijoittaja	Yksityinen pääoma-sijoitus-yhtiö	Koti-mainen rahoitus-laitos	Muu yritys	Muu	Oma pääoma (ilman pää-oma-lainoja) yht.
%	22.8 %	5.2 %	19.4 %	24.3 %	2.2 %	22.0 %	4.2 %	100.0 %
Yhteensä, miljoonaa euroa								215.0

Pääomalainojen jakautuminen rahoituslähteittäin											
	Yksityinen				Julkinen						
	Kotim. rahoi-tus-inst.	Ulkom. rahoitus-inst.	Ulko-maiset pääoma-sijoitus-yht.	Yksit. Pää-omasijoi-tus-yht.	Julk. Pää-oma-sij.	Sitra	Finn-vera	Tekes	Muu jul-kinen org.	Muu	Pää-omalainat yht.
%	0.6 %	0.0 %	4.0 %	18.1 %	0.4 %	13.7 %	0.3 %	53.4 %	0.0 %	9.6 %	100.0 %
Yhteensä, miljoonaa euroa											96.2

Vieraan pääoman (velan) jakautuminen rahoituslähteittäin												
	Rahoitusinstituutiot				Muut kuin rahoitusyhtiöt ja julkinen sektori							
	Koti-maiset pankit	Kotim. rahoi-tusyht.	Muut kotim. rahoitusl.	Ulkom. rahoitus-laitokset	Osto-velat	Muut yrityk-set	Finn-vera	Tekes	Muut julkiset org.	Joukko-velka-kirjat	Muu velka	Vieras pääoma yht.
%	14.5 %	3.2 %	0.0 %	0.0 %	31.8 %	5.5 %	6.5 %	13.3 %	4.4 %	0.4 %	20.4 %	100.0 %
Yhteensä, miljoonaa euroa												75.9

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1 Introduction

1.1 Aims

Presently, the biotechnology sector is seen as one of the most promising fields in terms of economic growth prospects in Finland and in other countries, too. The private and public sector have invested a lot in the sector's research and development activities. Some overall studies on the Finnish biotechnology sector have been made (e.g. Schienstock and Tulkki 2001; Hermans and Luukkonen 2002). Nonetheless, the ownership and financial structures prevailing in the biotechnology sector have not been studied in depth in Finland.[1] Hence, we need more knowledge about the financial sources of the sector.

The focus of this study is directed at the analysis of the ownership and financial structures of SME companies operating in the Finnish biotechnology sector that are younger than 25 years.[2] We show distributions of equity and debt by firm age, size and innovativeness. We benchmark our results to a recently conducted survey (Hyytinen and Pajarinen 2002), which addressed the same questions using data on Finnish SMEs in general. Berger and Udell (1998) provide the original approach for this type of study using US data. The aim of the study at hand is to provide detailed information on the financing and ownership patterns of biotechnology businesses in Finland. Our methodological approach is as follows: we (a) describe the ownership structures of biotechnology SMEs in Finland, (b) present distributions of the sources of the capital of these companies and (c) depict the interconnections between their financial structures, resources and business activities in general. Our methodological aim is to facilitate further theory-based empirical analysis with the help of this descriptive study.

1.2 Background

Frictionless access to finance is a critical success factor for a business of any kind. It can determine whether a business is started up in the first place, how fast it is able to grow, how vulnerable the business is to economic hardship and whether it is capable of utilizing emerging opportunities. In order to be functioning and accessible, the financial markets have to offer an array of solutions that meet the financial needs of businesses. These needs differ from sector to sector and are inherent in the unique characteristics of each of these sectors and the organizations operating within them. If one aims at providing a sound financial environment for a specific sector it is necessary to acquire a deep understanding of its financial needs first. Only a crisp comprehension of sector-specific financial demands provides the ability to design customized solutions to businesses with challenging financial needs.

With these issues in mind, we try to shed light on a previously almost uncharted business sector, the Finnish biotechnology industry. Biotechnology is a hot topic at the beginning of the third millennium. With the recent preliminary completion of the Human Genome Project, many previously unconquerable scourges of mankind have come into the reach of being overcome. Today we are able to alter any living organism and "improve" it. Organisms can be made immune to diseases, resistant against pesticides, they can be cloned, fitted with new foreign characteristics and modified to enhance our health. Diagnostics

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1 Lerner and Tsai (2002) have utilized US data on a set of biotechnology firms.

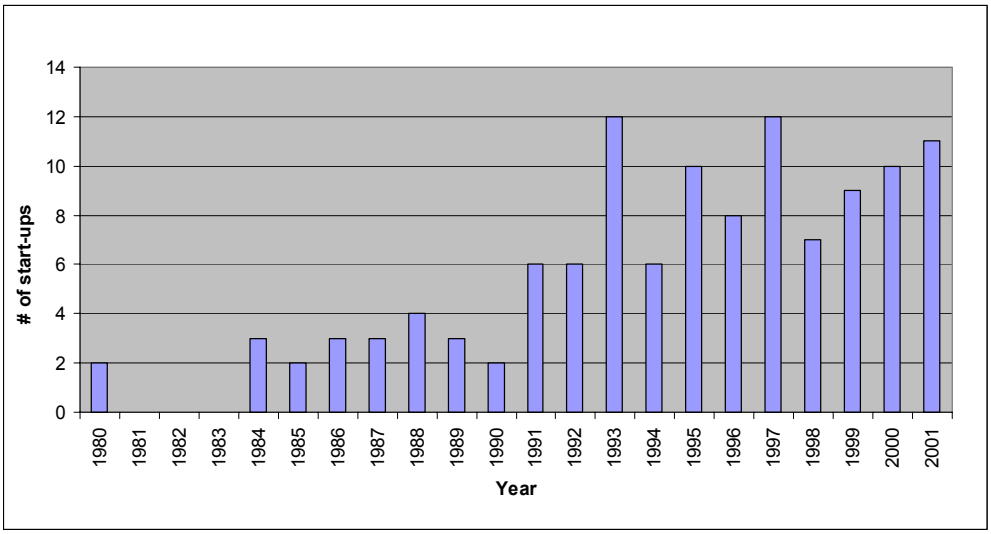
2 For detailed argumentation of the age limit refer to section *2.1 Raw data and sample weights*

become ever more accurate and faster. Materials can be equipped with new traits (like conductive plastics or bio-active glass) and existing production processes in almost every industry experience efficiency boosts, not to mention the array of completely new production processes and products. The possibilities are almost endless. The potential social, economic and not to forget ethical impacts are monumental.

Not only are the qualitative achievements impressive; the speed at which the Finnish biotech sector grows is imposing. Fifty per cent of the 133 biotechnology companies ever established in Finland were founded after 1995. Only 19 companies that report activity in the field of biotech today were founded before 1985.

After 1985 a change set in. Between ´85 and ´89 three times more companies were founded than in the previous five-year period, fifteen companies altogether. That is nearly half of the cumulative number of Finnish biotech companies that had ever existed until 1989. From the early days until now the average growth rate of the sector has been 16.4 per cent annually and is expected to remain at an average of 15 per cent. Figure 1.1 shows the distribution of Finnish biotech companies by the year of establishment. The strongly leftward skewing tail has been cut off at 1980.

Figure 1.1 **Finnish biotech companies by year of establishment**



On the single firm level growth expectations expressed by the expected annual growth rate of revenue for the next five years supports the immensely positive growth trend: the average annual growth rate of revenue is estimated to be 42%. However, the realized business activities of the biotechnology sector are still in an early phase. The total sales of the Finnish biotechnology firms was 143 million Euros in 2001 and many of the companies were confronted by losses (table 1.1).

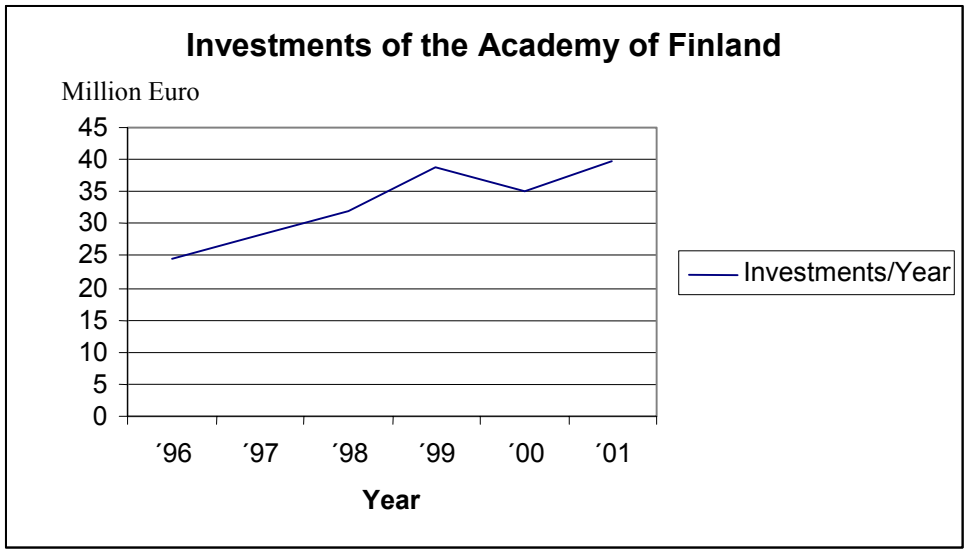
Table 1.1 Main economic indicators of Finnish biotechnology SMEs in 2001

Small and medium-sized biotechnology company active (total 106)	Amount
Personnel	1735
Sales, in million Euros	141
R&D costs, in million Euros	114
Profits, in million Euros	-96

In the wake of the rapid development of the biotechnology industry it is interesting to observe similar patterns in the evolution of Finnish financial markets. According to Kuusi (2001), public funding has been the major initiator and a fundamental base for the development of high-level knowledge in Finland. In the 1980s publicly funded organizations together with industry support started to invest heavily in R&D projects and continue to do so even today. In the 1990s alone the total public spending on biotechnology reached EUR 340 million. A large part of this funding was channeled through large-scale national research and technology programs that were run by the Academy of Finland and Tekes (the National Technology Agency). Another major player, Sitra, joined the funding in the mid 1980s.

The Academy of Finland operates under the supervision of the Ministry of Education and is engaged in research funding by financing high-level research through individual projects and programs, research posts, researcher training, centers of excellence and providing expert services to science policy issuers. In the year 2000 the Academy provided funds worth EUR 157 million, representing 12% of total public R&D expenditure in Finland. The Academy's financial support specifically to the biotechnology sector is hard to pinpoint. The reason is that the Academy itself does not monitor separately the funds flowing into the sector. The Academy's sector classification is broad and contains the following areas: biochemistry, molecular biology, microbiology, genetics, biotechnology, cell and evolution biology, physiology, pharmacy and so forth. Nevertheless, data from funding of this broader sector is available from the mid-nineties. Figure 1.2 displays the annual funding of the Academy that flowed to the biotech industry. It is readily apparent that the trend is upwards sloping.

Figure 1.2 **Investments of Academy of Finland in biotechnology in ´96-´01**[3]

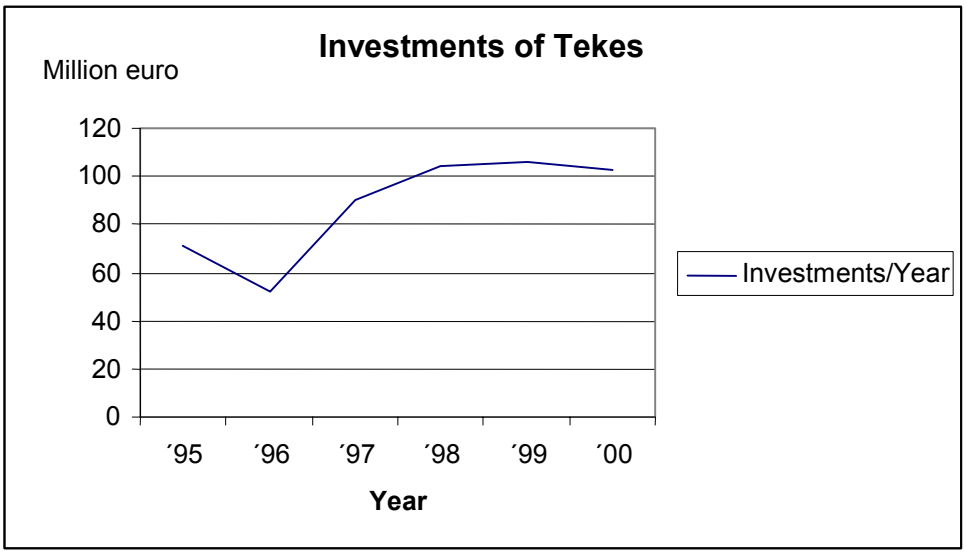


Tekes was established in 1983 and functions under the supervision of the Ministry of Trade and Industry. It is the major source of applied technology research funding. In 2000, Tekes supported 2,297 R&D projects worth EUR 370 million altogether, thirty per cent of which alone went to the biotechnology sector. The biotech sector along with IT are the main targets of Tekes funding. Especially biotech start-ups are given extra support. Again, the definition of the sector is broad and may vary from the definition of this paper. It comprises chemical industries in addition to biosciences. Nevertheless, the

[3] The Academy of Finland annual reports 1996-2001.

time series in figure 1.3 gives a good approximation of the investment trend. One can observe an increasing trend in the sector's investments again.

Figure 1.2 **Investments of TEKES in biotechnology in ´95-´00**[4]



Together with government ministries, Tekes and the Academy of Finland have massively contributed to the funding of the biotech sector with an observable increasing trend. Today they run seven major biotech related programs in different areas.

On the capital investors' side, development has worked in favor of the biotech sector as well. Especially in the past two or three years risk financing has become increasingly available. Today, early start-up capital is provided by over 40 venture capitalists on capital markets, not counting the Corporate Venture Capital actions of big companies nor private individuals (so-called business angels).[5] VCs started to emerge in the late eighties motivated by the restructuring of Finnish industries, increased investments into R&D and the increasing competitiveness of the Finnish economy. In 2001 VC's executed 449 single investments with a total worth of EUR 340 million. This is a decrease in the total investments of 14 per cent compared to the year 2000. Although the amount of invested money has declined, the number of single investments reached its all time peak in 2001. Out of 449 investments 244 were initial investments (EUR 221 million) and 205 were follow-up investments (EUR 119 million) in companies already existing in the VCs' portfolios. Investments were directed to 294 target companies. In 2001 Finnish VCs focused heavily on providing early phase funding. EUR 88 million (26%) was invested in early growth phase ventures. Private VCs prefer to support growth phase companies almost solely, whereas public VCs direct their investments into seed and rehabilitation stage ventures.[6]

A dominant capital investor is Sitra, an independent fund operating with a mandate from the Finnish government. By providing seed, start-up and expansion capital, Sitra supports the establishment of high-technology companies and the introduction of new forms of business. The organization finances its operations through endowment investments and capital gains. It is therefore not on an equal footing with public organizations. Sitra's investments into biotechnology have grown to an annual level of EUR 34 million. Here also the trend has been definitely positive: in 1999 Sitra's biotech investments totaled EUR 8.4 million and in 2000 the corresponding figure was EUR 20.2 mil-

4 Tekes annual reports 1995-2000
5 Finnish Venture Capital Association: Pääomasijoittaminen Suomessa 2001, p.5
6 Finnish Venture Capital Association: Pääomasijoittaminen Suomessa 2001, p.5

lion. Sitra has over 50 companies in its investment portfolio. (Kuusi 2001.) Again, one has to be cautious with the numbers since the definition of the biotechnology sector may vary from the definition of this paper. In the figures investments are targeted into a narrower biotech sector compared to the Academy of Finland or Tekes. Once more a strictly positive trend is observable.

Also other types of investors are recognizing the potential of the biotech sector. Among these are pension funds, for example. Foreign capital investors are entering the Finnish markets, too, with about 20 having made investments in biotechnology already.

Recalling the vast potential contributions of biotechnology to the problems of mankind, the enhancement of knowledge and understanding of biotechnology becomes an ethical imperative. As we argued earlier, it is of importance to understand the financial needs of an industry before one can create a sound financial environment that nourishes it. With the Finnish financial and biotechnology sectors growing and developing at a fast pace, they offer an attractive window of opportunity to explore the bilateral connections between them.

We proceed in section 2 with the presentation of our data. We also describe briefly the benchmark study of Hyytinen and Pajarinen (2002). Our proximate analysis consists of diverse distributions that describe patterns of financing and ownership in the biotech sector. This section displays an almost identical structure as compared to the benchmark study in order to facilitate easy comparison. In section 3 we conduct a principal component analysis (PCA). With the results of the PCA we depict the interconnections between their financial structures, resources and business activities in general. It will also be possible to point the direction for more theoretically based studies in the future. Section 4 concludes the paper.

2 Descriptives

2.1 Raw data and sample weights

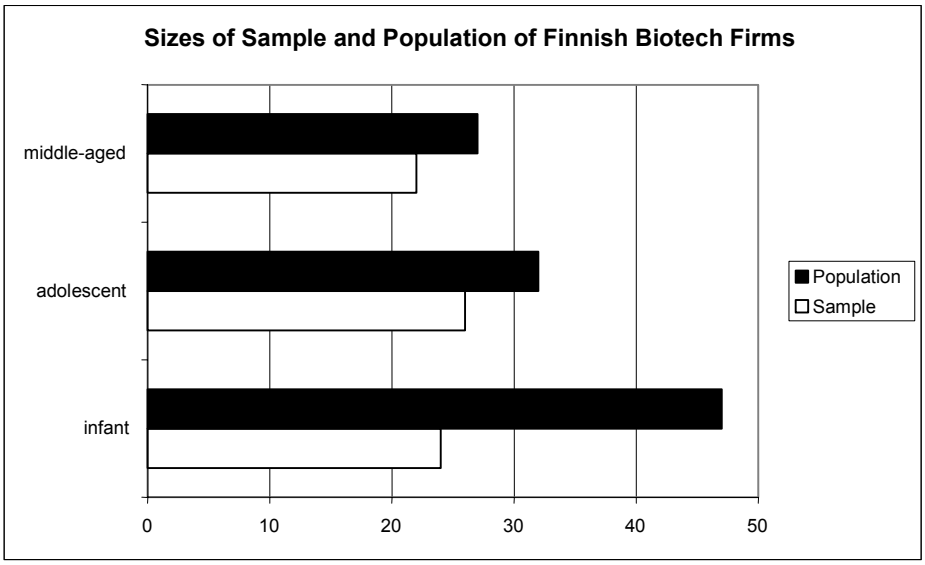
The empirical evidence in this paper is based on new data originating from a recently conducted private survey and data from the National Board of Patents and Registration of Finland (PRH). Primarily the survey data served as a basis for the analysis. Only in cases of controversial, inaccurate, missing or misleading data was the data from PRH used. No data from PRH was used that originated from periods prior to the year 2000. The survey covered the majority of companies operating in the Finnish biotechnology sector. Out of 120 active biotech companies at the end of 2001 our sample includes 84 companies of which 72 are small or medium-sized. The sample is somewhat smaller than the population for the following reasons. Firstly, the existence of a number of companies was unknown prior to the execution of the survey so that 116 companies were initially contacted. The contacts were based on the member list of the Finnish Bioindustries Association that tracks the development of and serves as a central organization for the Finnish biotech sector. One of the companies was tracked from the Internet. Out of these 116 companies, one was untraceable, 13 refused to respond, eight were operating in an irrelevant sector, three were not in operation, two had merged with another company and five could not be included due to other reasons. Altogether 8 companies were further excluded since they were too large to fit the definition of SMEs. Three companies were excluded because no sensible data was available on them. They were subsidiaries of bigger corporations and could not be properly separated from these in terms of equity and debt issues.

The companies in the final sample are either independent businesses, partnerships or subsidiaries of bigger corporations. In the latter two cases the businesses had to be independently responsible business units in order to be included in the sample. If the criteria were not fulfilled, the data was collected from the parent company. No companies that were 25 years of age or older met the criteria for inclusion. The majority of firms excluded for their large size belonged to the age category "old" and the remaining three "old" firms could not be included due to the lack of coherent data. Therefore the final sample consists of businesses in the first three age categories of Hyytinen and Pajarinen (infant, adolescent and middle-aged) and we limit the paper to Finnish biotechnology SMEs under 25 years of age. There are no severe outliers in terms of data on equity, capital loans or debt.

The relative sample size is large enough to give fairly accurate inferences about the capital and ownership structure of Finnish biotechnology companies. Nevertheless, since the data is based on the statements of individual experts and there is no data against which we could check the consistency and accuracy of our data itself, we caution that the estimates should be interpreted to give only a general idea of the financing sources of the Finnish biotechnology industry.

The data was weighted so that it could represent the whole population of Finnish biotechnology SMEs. The weights are constructed by the population-sample ratio of the three age categories presented in Figure 2.1.

Figure 2.1 **Distribution of population and sample sizes in age classes**



The middle-aged and adolescent classes are well represented with 81.3 and 88 per cent respectively. The youngest class is not as well represented, with the sample being 51.1 per cent of the total class population.

Our benchmark study of Hyytinen and Pajarinen (2002) analyzes the ownership and financial structures in Finnish SMEs in general. Their data stems from a private survey conducted in early 2002. Their sample covers 754 SMEs in various economic sectors in Finland; only agricultural, financial and real-estate sectors are excluded. The benchmark data is also weighted to represent the whole population of Finnish SMEs. Hyytinen and Pajarinen are especially interested in the sectors of high-technology and, therefore, overweight these sectors to give them a dominant representation. This overweighing in

the benchmark data adds value to our analysis since biotechnology is by definition a high-technology sector: the results of the benchmark study and our analysis are truly comparable and of high value. The overlap between our data and the benchmark data is negligible. Table 2.1 displays the data.

Table 2.1. Comparison between Finnish biotech firms and all the small and medium-sized firms in Finland[7]

		SME biotech companies in ETLA survey		Finnish SME companies in total[8]
		N	%	%
Turnover in million euros	< 0.2	36	50 %	15 %
	0.2-1.5	23	32 %	56 %
	1.6-8.0	8	11 %	24 %
	>8	5	7 %	5 %
Number of employees	<5	31	43 %	44 %
	5-20	21	29 %	41 %
	>20	20	28 %	15 %
Age of firm, years	0-2	11	15 %	5 %
	3-4	13	18 %	9 %
	5-24	48	67 %	70 %
	>24	0	0 %	16 %
Exports / turnover	0 %	27	38 %	70 %
	0-1 %	1	1 %	22 %
	2-5 %	6	8 %	4 %
	6-10 %	1	1 %	2 %
	>10 %	37	51 %	3 %
	N/A	1	1 %	0 %
R&D expenditure / total costs (The total population of Finnish companies: R&D exp. / turnover)	0 %	8	11 %	53 %
	0-1 %	2	3 %	23 %
	2-5 %	2	3 %	13 %
	6-10 %	3	4 %	3 %
	>10%	55	76 %	6 %
	N/A	2	3 %	0 %
Predicted annual growth rate of turnover for the next 5 years (3 years in total)	<0 %	0	0 %	1 %
	0-1 %	4	6 %	31 %
	2-5 %	0	0 %	20 %
	6-10 %	7	10 %	23 %
	>10 %	59	82 %	21 %
	N/A	2	3 %	5 %
Holds patents	Yes	45	63 %	6 %
	No	27	37 %	94 %
Total number of observations		72	100 %	754

[7] Eleven firms were classified as large firms in the original sample. Hence, biotech firms presented above were small and medium-sized enterprises (SME). The firm was classified as a large company if two out of the three following conditions were matched: the firm has more than 250 employees, its turnover is more than EUR 40 million, or its total assets are more than EUR 27 million.

[8] Hyytinen and Pajarinen (2002) weight the data of Finnish firms in total to replicate the Finnish small business population as a whole.

2.2 Distributions of equity and debt by firm age and size

In the following we focus on the influence of firm size and age on the distributions of equity, debt and capital loans in our sample. By comparing our findings to the benchmark study we try to distinguish characteristic traits of the Finnish biotechnology SME financing.

2.2.1 Overview

The estimated distributions of the fund sources of the Finnish biotechnology sector are displayed in tables 2.2.A - 2.7. The tables include a grouping by firm size and age. The category definitions of firm size and age are identical to those of Hyytinen and Pajarinen (2002).

The firm size is split into two categories, small and large. A firm is small when the total labor force remains below 20 *and* the annual revenue stays below EUR 1 million. If one or more criteria are exceeded, the firm belongs to the category "large". The firm age is divided into four categories out of which only the three youngest are effectively in use. If a firm is established before 1977 (25 years of age and older), it is considered *old*. Firms founded between 1977 and 1992 are labeled *middle-aged* (9 to 24 years of age). The category *adolescent* consists of firms established between 1993 and 1996 (5 to 8 years of age) and the remainder of the sample, firms started between 1997 and 2001 (0 to 4 years of age), belong to the category *infant*.

Tables 2.2.A – 2.2.C show the distribution of equity, capital loans and debt. The appearance and content of the table deviates from that in the benchmark study. Due to the R&D intensive nature of biotechnology[9], which often implies long periods of investment in research without positive revenue streams, the accumulated earnings from previous periods are frequently negative. In the benchmark study equity is defined as the difference between total equity and capital loans, which are a part of total equity on the balance sheet. Together with the influence of negative earnings from previous periods being an element of total equity on the balance sheet, the subtraction of capital loans from total equity results in negative equity within some groups.

Therefore, it is not appropriate to present split distributions of "principal owner's equity" and "other equity" as it is done in the benchmark study. Without our corrections described later, the negative equity of some observations neutralizes the positive equity of others and no sensible information on principal owner's equity can be obtained, as it can never be negative in reality. Thus, we first imitate the definition of equity in the benchmark study by subtracting capital loans from total equity, but present the distributions in an aggregate manner (see table 2.2.A). In order to be able to present detailed and sensible distributions of equity sources, we then correct the structure of equity for the losses of previous periods and make sure equity is never negative[10]. After the cor-

[9] It will be shown in section 2.3 that biotechnology SMEs in Finland are highly R&D intensive in terms of R&D to total cost ratio.

[10] We used three alternative definitions for equity:
a) Equity equals the difference between total equity and capital loans
b) Equity equals the stockholders' paid-in capital obtained from National Board of Patents and Registration of Finland
c) Equity equals the minimum legal level of equity.
We used the highest value of obtained from different definitions. This is due to the idea that even when firms' balance sheets are distorted by great losses, they do not necessarily reflect the level of expected earnings. Negative equity figures distort also the counting of equity shares. If we take official paid-in capital figures on stockholders' equity we get the value that stockholders' have invested in a company.

rection we are able to split the principal owner's equity from the residual equity and present a distribution of equity, capital loans and debt (table 2.2.C), which is directly comparable to the table 3.2 in the benchmark study.[11]

Table 2.2.A Estimated distribution of aggregate equity, capital loans and debt by firm size and age

	Equity	Capital loans	Debt	Total
A: All (N=72)				
%	43.6 %	31.5 %	24.9 %	100.0 %
(amount, mill.€)				305.3
B: Breakdown by size of SME				
Small	-6.9%	70.9 %	36.0%	100.0 %
(amount, mill.€)				32.7
Large	49.3 %	27.1 %	23.6 %	100.0 %
(amount, mill.€)				274.7
C: Breakdown by age of SME				
Infant	39.5 %	46.2 %	14.3 %	100.0 %
(amount, mill.€)				162.7
Adolescent	41.0 %	27.0 %	32.0 %	100.0 %
(amount, mill.€)				64.1
Middle-aged	54.4 %	4.6 %	41.0 %	100.0 %
(amount, mill.€)				78.4
Old	n.a.	n.a.	n.a.	n.a.
(amount, mill.€)				n.a.

In table 2.2.A panel A we see that Finnish biotech SMEs rely on equity for 43.6% of their financing. The equivalent number of the benchmark is 46.3% insinuating that the importance of equity as a source of funding seems to be almost equal. The differences with respect to the benchmark can be found in the relative importance of capital loans to debt. While according to our findings biotech SMEs rely heavily on capital loans (31.5% of the total funding), for SMEs in general capital loans are a very marginal funding source with just 1.9%. This could reflect the fact, that conventional debt is cheaper than capital loans, although payback conditions are harsher, and are therefore taken by firms that operate in a relatively risk free business environment where revenue streams are predictable and payback plans can be established. Capital loans are more expensive than conventional debt but do not have to be paid back if the profit situation does not allow for it. Capital loans are therefore more suitable for firms operating in a very risky environment like the biotechnology sector.[12] As a consequence, biotechnology SMEs rely on debt for 24.9% of their funding. The benchmark number is 51.9%.

Panel B tells us that the financial solvency of small biotech SMEs is very poor. After subtracting capital loans from total equity the residual sector equity is negative. When firms grow beyond the category "small", their solvency strengthens explosively to a

Finally, we defined equity according to the definition c, if the value of equity was less or there was a lack of data in categories a and b. This method of constructing the ownership structure can be based on the concept of limited liability of owners. For instance, if a company goes into bankruptcy, the owners of the company can potentially get back positive equity via accumulated earnings but they are not liable to pay back negative equity due to the accumulated losses. Therefore, the limited liability approach enables us to form asymmetrically the positive equity figures described above.

[11] Of course in table 2.2.C firms seem to be more solvent than in reality, because losses of previous periods have been neutralised.

[12] Research-intensive sectors are risky due to the very uncertain nature of R&D.

level of close to 50%. Small biotech companies use capital loans to a large extent to finance their activities (over 70%) and rely also, although not as heavily, on conventional debt (36%). This structure is very dissimilar to that of the benchmark, where small firms employ capital with 35.4% to finance their activities and are therefore financially very much sounder than their counterparts in the biotech sector. Large biotech SMEs are, on the other hand, more solvent than those in the benchmark study. Large biotech firms' equity captures a share of 49.3% of the total funding while the comparable benchmark is 40.5%. They still utilize capital loans to a much larger extent than in the benchmark (27.1% vs. 1.3%), but are less indebted than the benchmark firms (23.6% vs. 58.2%).

Panel C reveals that as the biotech SMEs mature in age, their solvency improves monotonously from 39.5% in the category "infant", over 41% in the category "adolescent", to 54.4% in the oldest category "middle-aged". In the same time the share of capital loans of total equity decreases rapidly and monotonously from 46.2% (infant) to 4.6% (middle-aged). Capital loans are surpassed in importance by conventional debt already in the age category "adolescent" (27% vs. 32%). This smoothly monotonous pattern in every finance source category is not backed up by the benchmark study. The findings of panel C support those of panel B and are intuitively logical.

Another fundamental explanation for the heavy use of capital loans instead of conventional debt is the fact that in order to avoid bankruptcy, firms with big losses from previous periods have to improve their solvency by increasing their total equity. Since capital loans are counted as equity on the balance sheet, they improve solvency. It seems sensible that young biotech firms do not yet have the revenue streams to keep annual profits positive and have to shore up their solvency figures in order to avoid bankruptcy.

Table 2.2.B Estimated distribution of aggregate equity, capital loans and debt by firm size and age (corrected for the past losses)

	Equity	Capital loans	Debt	Total
A: All (N=72)				
%	55.6 %	24.8 %	19.6 %	100.0 %
(amount, mill.€)				387.1
B: Breakdown by size of SME				
Small	30.5 %	46.1 %	23.4 %	100.0 %
(amount, mill.€)				47.1
Large	59.0 %	21.9 %	19.1 %	100.0 %
(amount, mill.€)				340.0
C: Breakdown by age of SME				
Infant	54.1 %	35.0 %	10.8 %	100.0 %
(amount, mill.€)				214.6
Adolescent	57.3 %	19.6 %	23.2 %	100.0 %
(amount, mill.€)				88.5
Middle-aged	57.4 %	4.3 %	38.3 %	100.0 %
(amount, mill.€)				84.0
Old	n.a.	n.a.	n.a.	n.a.
(amount, mill.€)				n.a.

Table 2.2.B shows exactly the same distributions as table 2.2.A except that the equity is corrected for the losses of previous periods and approximates the invested capital put into the biotech sector in a better way. We see that the shares of equity are almost constant throughout the age categories, which insinuates that the older a firm gets, the less

losses from previous periods it has to bear. Otherwise, the patterns already explored in table 2.2.A are backed up by the patterns in table 2.2.B.

Table 2.2.C Estimated distributions of equity, capital loans and debt by firm size and age

	Sources of equity			Capital loans			Sources of debt				
	Principal owner	Other equity	Total equity	Private	Public	Total cap. loans	Financial instit.	Other instit.	Other debt	Total debt	Total debt and equity
A: All (N=72)											
%	12.9 %	41.5 %	54.5 %	9.8 %	16.5 %	26.3 %	3.4 %	5.7 %	10.1 %	19.2 %	100.0 %
(amount, mill.€)											394.7
B: Breakdown by size of SME											
Small	11.1 %	19.3 %	30.5 %	19.3 %	26.8 %	46.1 %	4.4 %	10.9 %	8.1 %	23.4 %	100.0 %
(amount, mill.€)											47.1
Large	13.2 %	44.6 %	57.7 %	8.5 %	15.1 %	23.6 %	3.3 %	5.0 %	10.4 %	18.7 %	100.0 %
(amount, mill.€)											347.7
C: Breakdown by age of SME											
Infant	4.7 %	49.5 %	54.1 %	13.9 %	21.1 %	35.0 %	2.2 %	3.2 %	5.4 %	10.8 %	100.0 %
(amount, mill.€)											214.6
Adolescent	13.2 %	44.1 %	57.3 %	0.6 %	19.0 %	19.6 %	0.5 %	10.6 %	12.0 %	23.2 %	100.0 %
(amount, mill.€)											88.5
Middle-aged	32.1 %	20.5 %	52.6 %	8.9 %	3.4 %	12.3 %	9.1 %	6.8 %	19.2 %	35.1 %	100.0 %
(amount, mill.€)											91.6
Old	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
(amount, mill.€)											n.a.

Table 2.2.C imitates the structure of table 3.2 of the benchmark study. In this table we use equity, which is corrected for losses of previous periods in order to obtain sensible and descriptive information. Therefore, firms again seem to be more solvent than they are in reality. The category "Principal owner" defines the amount of equity owned by a shareholder who is among the five largest owners expressed in terms of the number of votes and who exerts considerable control over the firm's governance and financial structure. For a number of firms the principal owner is defined as the largest shareholder. The rudiment of shareholders' equity is captured by the category "Other equity". The category "Private" capital loans comprises funds provided by financial institutions and other privately run organizations, whereas "Public" capital loans stem from the National Technology Agency (Tekes), Finnvera plc (a state owned financing company), Sitra and other governmental institutions.[13] Debt from "Financial institutions" originates from banks, insurance companies, pension funds, finance companies, foreign financial institutions and other credit institutions. The debt category "Other institutions" includes funds from government sources and non-financial firms. The category "Other debt" consists of debt from trade credit, commercial papers and bonds, private individuals and other unidentifiable sources.

Table 2.2.C reveals that Finnish biotechnology SMEs' funding stems primarily from equity (54.5%). The biotech sector is more equity intensive than SMEs in general with a ten per cent difference to the benchmark and are thereby less indebted than Finnish SMEs in the benchmark. The (capital loans inclusive) debt ratio is 45.5% (54% in the benchmark). The by far most important source of funds is non-principal owner equity

[13] For more detailed information on Tekes and Sitra see above. Finnvera provides subsidised loans and guarantees and other financial services with the aim of promoting domestic and international operations of Finnish SMEs. On top of that, 16 Regional Employment and Economic Development Centres offer financial and non-financial public support to SMEs.

with 41.5% of the total debt and equity. This deviates again from the benchmark, which identifies principal owner equity as the most important source with an equivalent figure of 29%. The non-principal owner equity in the benchmark accounts for only 16.8% of the total funding. In general one could infer that the equity funding of Finnish biotechnology firms is less concentrated than the equity funding of Finnish SMEs in general. Capital loans are the second biggest source of funds with 26.3 per cent of the total funding. The majority of capital loans originates from public sources with 16.5% of the total funding. In comparison with the benchmark data, for Finnish biotech SMEs capital loans seem to be a major pillar of funding. Where the biotechnology sector draws over one fourth of its financing from capital loans, the corresponding figure in the benchmark study is merely two per cent (1.9%). The biotechnology SMEs definitely prefer capital loans over debt. With 19.2 per cent of the total funding, debt is also a significant source but cannot compete with equity and capital loans in importance. It is also far less significant in importance than debt in the benchmark data, where debt accounts for 51.9% of the total debt and equity. The significance decreases even more when correcting the data for trade-related credit, which constitutes approximately one fourth (24.1%) of the total debt. Finally, the third most important single source of funding is principal owner's equity with 12.9%. Compared to the benchmark (29%) this is rather low and not typical for SMEs. In the benchmark study the principal owner's equity is identified as the most important source of funding for Finnish SMEs. As a whole, the findings deviate strongly from the financial structure patterns suggested by Pajarinen and Hyytinen.

Panel B reveals that findings in the biotech sector differ strongly from the findings of SMEs in general. In contradiction with Hyytinen and Pajarinen, we find that small biotech SMEs are more indebted than their larger rivals. The debt ratios are 69.6% and 42.2% accordingly. This vast gap is partly due to a large share of capital loans used by small companies (46.1 % of total funding). Nevertheless, looking at the percentages of the funding of conventional debt supports the finding that small biotech SMEs are more indebted than their larger counterparts (23.4% vs. 18.7% respectively). Also deviating from the findings of the benchmark study, neither of the two size categories show the principal owner to be the most important source of funding. The small biotech SMEs draw over one fourth of their funds from public capital loans (26.8%), whereas the large companies lean very heavily on non-principal owner equity (44.6%).

In panel C the grouping by the age of the firm shows a non-monotonic debt ratio lifecycle of biotech firms. The pattern is similar to that in the benchmark study, although the total levels of the debt ratio in this paper are lower by slightly over 10% and the variance between age categories is not as dramatic. In the biotech sector firms categorized as "infant" show a relatively high (capital loans inclusive) debt ratio of 45.8%. With the firm age the debt ratio decreases to 42.7% in the "adolescent" category only to rise again to a maximum of 47.4% among the "middle-aged" firms. The relatively high debt ratio in the category "infant" stems from the heavy reliance on capital loans (public and private altogether 35% of the total debt and equity), which is replaced by conventional debt when the firms grow older. As a matter of fact, in the "middle-aged" category capital loans have been effectively replaced by debt representing 35.1% of funding (as compared to 12.3% for capital loans). Parallel to the findings of the benchmark study, the share of the principal owner's equity grows as the firms get older. In the biotech sector this development seems to be even more monotonic than in the benchmark study, almost tripling from age category to age category (4.7% -> 13.2% -> 32.1% -> n.a. as compared to 9.7% -> 33.0% -> 22.3% -> 40.9%). In the same time total equity stays at relatively stable levels. This insinuates that the principal owner is buying shares from other shareholders while the firm ages.

To highlight the major difference between the findings of this paper and those of the benchmark study it has to be said that capital loans play a role many times more important in the biotech SME sector than among Finnish SMEs in general and seems to replace conventional debt.

2.2.2 Sources of equity

Table 2.3 elaborates the distribution of equity between the different sources of equity in a detailed fashion.

Table 2.3 Estimated distribution of equity by firm size and age

		Individuals		Institutions					
	Principal owner	Managers & empl.	Other individ.	Public vc	Private vc	Financial instit.	Other firms	Other equity	Total sources of equity
A: All (N=72)									
%	23.7 %	21.3 %	5.2 %	16.1 %	23.4 %	2.2 %	7.0 %	1.2 %	100.0 %
(amount, mill.€)									215.1
B: Breakdown by size of SME									
Small	36.4 %	14.3 %	2.7 %	27.0 %	6.7 %	1.7 %	7.1 %	4.0 %	100.0 %
(amount, mill.€)									14.4
Large	22.8 %	21.8 %	5.3 %	15.3 %	24.6 %	2.2 %	7.0 %	1.0 %	100.0 %
(amount, mill.€)									200.7
C: Breakdown by age of SME									
Infant	8.6 %	28.4 %	6.1 %	18.6 %	37.2 %	0.5 %	0.4 %	0.3 %	100.0 %
(amount, mill.€)									116.1
Adolescent	22.9 %	19.5 %	7.7 %	24.4 %	12.6 %	7.6 %	1.4 %	3.7 %	100.0 %
(amount, mill.€)									50.8
Middle-aged	61.0 %	6.0 %	0.2 %	1.3 %	1.5 %	0.5 %	28.9 %	0.6 %	100.0 %
(amount, mill.€)									48.2
Old	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
(amount, mill.€)									n.a.

As can be seen in panel A, principal owner's equity is marginally the most important source of equity with 23.7%. This is in line with Hyytinen and Pajarinen (2002) although their corresponding number is 63.6%. The second most important equity sources are private venture capitalists with 23.4% of the total sector equity. The equivalent number in the benchmark study is about 1%, with private VC ranking 6th in importance. In third place come managers and employees of the particular firms providing 21.3% of equity. In the benchmark study this group is the second most important source with 24.3% and is, thereby, structure-wise approximately equally important. Public venture capitalists rank fourth with 16.1% followed by "other firms" with 7% respectively. "Other individuals" (5.2%), financial institutions (2.2%) and "other equity" (1.2%) compose the residual sources of equity. It is easy to see that equity in the benchmark study is heavily concentrated around the principle owner. In the case of biotech SMEs equity is distributed more evenly among different sources. The total VC (public + private) is a dominating source of finance in the biotech sector with a compound percentage of 39.5%, which is in strong contradiction with the 1.2% total VC funding in the benchmark study. It seems that in the biotechnology sector the principal owner's equity has been replaced by equity from venture capitalists since the contributions of the remaining equity sources follow almost equal patterns in both studies and vary by 3.1% at a maximum from each other (category "Other firms").

The grouping by the firm size in panel B of table 2.3 gives us the distributions in two classes. In contradiction with the benchmark study, in small biotech firms the principal owner's equity has a larger share of the total equity than larger companies (36.4% vs. 22.8%). Conversely, managers and employees own a bigger share in large companies than in small ones (21.8% vs. 14.3%), which is again contradictory to the benchmark. An explanation for these findings could be found in the principal-agent theory. In businesses based primarily on tacit knowledge (as is the case in the highly R&D intensive biotech sector) information asymmetries complicate monitoring of the agent (biotech SME) by the principal (investor). In this case the principal tries to align the interests of the agent and the principal himself by shifting power (shares) to the agent. This way, operating in favor of the principal benefits also the agent. This is precisely what seems to happen in panel B. The principal owner trades his/her equity for the equity of "managers and employees" as the firm grows. An interesting observation is that *public* VCs own a relatively large share of equity in small biotech companies with 27% (the second most important equity source for small businesses) as compared to 15.3% in large firms. On the other hand, the ownership portion of *private* VCs is relatively small (6.7%) in small businesses as compared to the portion in large companies, which is fairly high with 24.6% (the single most important source of equity for large companies). This pattern is in line with the pattern in the benchmark study, although the differences between small and large businesses are not as radical as in this paper and the ownership portions of VCs are very much smaller than in this paper. Also the facts that private VCs focus on growth phase firms and public VCs concentrate on providing seed capital for young and small companies (see introduction) back up the findings of panel B.

Panel C reveals that the share of the principal owner equity of total equity rises at an swift pace as the firms mature. Starting in the category "infant" with 8.6% of principal owner's equity, the portion rises by 14.3 percentage points to a level of 22.9% in the category "adolescent" and by further 38.1 percentage points to the level of 61% (!) of the total equity in the category "middle-aged" reaching a level almost equal to that of the benchmark study (57.9%). With the exception of the category "middle-aged", principal owner's equity is not the most important source of equity. In the category "infant" *private* venture capitalists provide the lion's share of equity to the biotech companies with a dominant 37.2%. Managers and employees act as the second most important source with 28.4%. Firms in the category "adolescent" draw their capital mainly from *public* VCs with 24.4% of the total equity. Here the principal owner is the second most important with 22.9%. Managers and employees come in third with a 19.5% portion of the total equity. Middle-aged firms are owned with a 61% stake by the principal owners and 28.9% by other firms. These two owner categories own together the portion of 89.9% of the equity of middle-aged firms. What makes this observation even more interesting is the fact that (as seen later in table 2.5) over 72% of the principal owners in the category "middle-aged" consist of other firms. Therefore, middle-aged firms are owned with a dominant majority by other firms.

Tables 2.3 and 2.4 facilitate the comparison of relativity between inside and outside equity for Finnish biotech SMEs. The information for the computation of "broad inside equity" is provided by table 2.3. Broad inside equity is defined as the sum of the principal owner's equity and the equity supplied by managers and employees. The residual equity is titled "outside equity". "Narrow inside equity" can be calculated from table 2.4, where the principal owner's equity is disaggregated and distributed to the different equity categories by the identity of the owners. Narrow inside equity is the portion made available by individuals that are actively involved in the daily business of the company (category "active in business"). Again, we define the remaining equity as "outside equity".

From table 2.3 we can infer that although broad inside equity is a very important equity source with 45% of the total equity among Finnish biotech SMEs it is by far not as dominant as in the benchmark study. Especially the VC sector competes very closely for dominance as an equity source with a compound 39.5%. In line with the benchmark small businesses rely more heavily on broad inside equity than large firms with 50.7% vs. 44.6%, but on a lower level than in the benchmark. The use of broad inside equity rises monotonically over the age categories with 37%, 42.4% and 67% respectively, which is in contradiction to the non-monotone pattern in Hyytinen and Pajarinen (2002).

Table 2.4 Estimated distribution of equity (principal owner disaggregated) by firm size and age

	Individuals		Institutions					
	Active in business	Other individ.	Public VC	Private VC	Financial instit.	Other firms	Other equity	Total sources of equity
A: All (N=72)								
%	22.8 %	5.2 %	19.4 %	24.3 %	2.2 %	22.0 %	4.2 %	100.0 %
(amount, mill.€)								215.0
B: Breakdown by size of SME								
Small	32.1 %	2.8 %	27.1 %	7.3 %	1.8 %	24.9 %	4.0 %	100.0 %
(amount, mill.€)								14.4
Large	22.1 %	5.3 %	18.8 %	25.5 %	2.2 %	21.8 %	4.2 %	100.0 %
(amount, mill.€)								200.7
C: Breakdown by age of SME								
Infant	28.9 %	6.1 %	24.0 %	37.8 %	0.5 %	2.4 %	0.3 %	100.0 %
(amount, mill.€)								116.1
Adolescent	22.7 %	7.7 %	25.8 %	14.2 %	7.6 %	18.1 %	3.7 %	100.0 %
(amount, mill.€)								50.8
Middle-aged	8.2 %	0.2 %	1.3 %	2.3 %	0.5 %	73.3 %	14.2 %	100.0 %
(amount, mill.€)								48.2
Old	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
(amount, mill.€)								n.a.

Table 2.4 gives us support to the findings of table 2.3. Although narrow inside equity is an important equity source (second most important single source after private VC), it is tiny compared to the portion in the benchmark study with 22.8% vs. 83.1% (panel A). Narrow inside equity is also more important to small biotech SMEs than to the large ones. However, in contradiction with the findings of table 2.3 the portion of narrow inside equity diminishes monotonically from age category to age category with 28.9%, 22.7% and 8.2% respectively (panel C). The decline goes hand in hand with a steep monotone rise of the equity shares the "other firms" (2.4%, 18.1% and 73.3% respectively). This indicates the growing dominance of other firms as the principal owner as the lifecycle of firms proceeds. This finding is confirmed in table 2.5. In the younger age categories the compound VC sector is a major source of capital.

Table 2.5 reveals the identity of the principal owner and distributes its equity over five identity categories: those actively participating in the daily business of the company, other individuals, the VC sector, other firms and other institutions. As compared to the benchmark, the great discrepancy of the role of individuals active in the business as the principal owner is eminent. In the Finnish biotech SME sector only 6.3% of the principal owner's equity stems from individuals active in the business. In the benchmark the comparable figure is an overwhelming 92%. In fact, individuals active in the business are the second least important group of principal owners right before non-active individuals. The portion of other firms on the other hand is fairly large with 63.4%.

Table 2.5 Estimated distribution of principal owner's equity by firm size and age

	Individuals	Institutions				
	Active in business	Other individ.	Venture Capital	Other firms	Other instit.	Total principal Owner
A: All (N=72)						
%	6.3 %	0.0 %	17.5 %	63.4 %	12.8 %	100.0 %
(amount, mill.€)						51.0
B: Breakdown by size of SME						
Small	49.1 %	0.1 %	1.6 %	49.1 %	0.1 %	100.0 %
(amount, mill.€)						5.2
Large	1.4 %	0.0 %	19.3 %	65.0 %	14.3 %	100.0 %
(amount, mill.€)						45.8
C: Breakdown by age of SME						
Infant	5.1 %	0.1 %	70.5 %	24.3 %	0.0 %	100.0 %
(amount, mill.€)						10.0
Adolescent	14.1 %	0.0 %	13.0 %	72.9 %	0.0 %	100.0 %
(amount, mill.€)						11.6
Middle-aged	3.6 %	0.0 %	1.3 %	72.8 %	22.3 %	100.0 %
(amount, mill.€)						29.4
Old	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
(amount, mill.€)						n.a.

The equivalent figure in the benchmark is 1.3%. Panel B shows that although the portion of principal owner's equity held by individuals active in the business is quite high in small businesses (49%), it deteriorates at a steep rate down to 1.4% when the company grows to be large. At the same time the portions of all but "other individuals" rise remarkably. In panel C one can see that the portion of the principal owner's equity in the category VC is initially large with 70.5% but declines monotonically to 1.3% as the portion of other firms increases from 24.3% to 72.8% at the same time. Those active in the business never play a dominant role in the lifecycle of companies. The only exception is in the transition phase from infant to middle-aged when their portion of principal owner's equity rises to a peak of 14.1%. One can say that as firms get bigger and older, the control of individuals active in the business decreases and that of other firms increases. In larger companies control is distributed more evenly between different sources than in small companies, where control is split between business active individuals and other firms.

2.2.3 Sources of debt[14]

Table 2.6 displays the distribution of debt over 10 source categories. These include domestic banks, domestic finance firms, other domestic financial institutions e.g. insurance companies, foreign financial institutions, trade credit and other non-financial businesses, governmental sources Finnvera, Tekes and other governmental bodies including all the rest of the governmental sources. The eleventh category "Other debt" originates from individuals and accruals, for example.

[14] Capital loans *not* included.

Table 2.6 Estimated distribution of debt by firm size and age

	Financial institutions				Non-financial business and government							
	Domestic banks	Domestic finance firms	Other dom. fin. instit.	Foreign financial instit.	Trade credit	Other non-fin. Business	Finnvera	Tekes	Other govt.	CPs and bonds	Other debt	Total sources of debt
A: All (N=72)												
%	14.5 %	3.2 %	0.0 %	0.0 %	31.8 %	5.5 %	6.5 %	13.3 %	4.4 %	0.4 %	20.4 %	100.0 %
(amount, mill.€)												75.9
B: Breakdown by size of SME												
Small	9.8 %	9.0 %	0.0 %	0.0 %	13.7 %	8.1 %	14.3 %	11.8 %	12.3 %	0.0 %	21.1 %	100.0 %
(amount, mill.€)												11.0
Large	15.3 %	2.2 %	0.0 %	0.0 %	34.9 %	5.0 %	5.2 %	13.5 %	3.1 %	0.5 %	20.3 %	100.0 %
(amount, mill.€)												64.9
C: Breakdown by age of SME												
Infant	14.0 %	6.6 %	0.0 %	0.0 %	19.4 %	3.4 %	7.7 %	17.1 %	1.3 %	0.0 %	30.5 %	100.0 %
(amount, mill.€)												23.3
Adolescent	2.0 %	0.0 %	0.0 %	0.0 %	45.6 %	2.4 %	9.5 %	23.4 %	10.6 %	0.0 %	6.4 %	100.0 %
(amount, mill.€)												20.5
Middle-aged	22.8 %	2.7 %	0.1 %	0.0 %	31.9 %	9.0 %	3.6 %	4.0 %	2.8 %	1.1 %	22.1 %	100.0 %
(amount, mill.€)												32.1
Old	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
(amount, mill.€)												n.a.

Not regarding the aggregate category "other debt", it is obvious that trade credit is the dominating source of conventional debt in the biotechnology SME sector. This finding is in line with the benchmark study. Only small firms draw their debt to a larger extent from Finnvera than from trade credit. The percentage of the trade credit of the total debt is constantly over 30% except for the smallest and youngest companies. The predominance of trade credit throughout almost every category does not necessarily mean that in the biotech sector procurement played a relatively big role in business activities but rather indicates a relatively low debt share of the total funding and a state of the capital adequacy. In general (panel A), domestic banks constitute the second most important source of debt to the biotech SMEs with 14.5%. This finding also coincides with the benchmark study where the equivalent percentage is 26%. The third most important source of debt is Tekes with 13.3% of total debt funding. Finnvera is ranked fourth with 6.5% of the total debt. Credit from other non-financial businesses plays a relatively more important role than in the benchmark (5.5% vs. 0.3%). "Other governmental" sources are also relatively more important to the biotech SMEs than to Finnish SMEs in general (4.4% vs. 0.5%). CPs and bonds play an insignificant role in both studies. It is interesting to observe that the percentage of debt originating from "other domestic financial institutions" and "foreign financial institutions" is zero at least up to the second decimal. The figures in the benchmark are here somewhat higher (2.1% and 0.3% respectively).

Panel B reveals that small biotech SMEs lean heavily on governmental debt with an aggregate 38.4% (Finnvera + Tekes + other govern., over 10% each) of total debt, although trade credit is the second most important single source of debt. In large companies trade credit plays a significantly more important role and domestic banks have become the second most important source of debt with 15.3%. The large share of trade credit speaks of a generally low debt ratio of large biotech SMEs. From the various governmental sources only Tekes has prevailed as an important debt provider with 13.5%.

In panel C one can observe that the debt structure of infant biotech SMEs resemble very much that of large companies. In the category "adolescent" the structure resembles that of small businesses with an even more extreme weight on governmental debt sources and

trade credit. The aggregate percentage of governmental debt and trade credit in this category is a huge 89.1%. It has to be remarked that in this category only "other debt" falls below 20% with 6.4%. The debt structure of middle-aged firms swings again in the other extreme. Debt from domestic banks, domestic finance firms and trade credit constitutes 57.4% of the total debt.

In summary, the debt structure in general resembles that of the benchmark study but fluctuates significantly more from one size and age category to the other. Small businesses prefer governmental debt, whereas larger firms are able to draw relatively more debt from financial markets. Infant firms are obviously able to draw debt both from financial markets and governmental sources, adolescent companies raise their debt to a very large extent from governmental sources and, finally, the debt of middle-aged biotech SMEs originates from financial markets and other non-financial businesses.

2.2.4 Distribution of capital loans

Due to the fact that capital loans seem to play such a prominent role in the financial structure of Finnish biotechnology SMEs we deviate from the structure of the benchmark study again and show here the disaggregated distribution of capital loans over nine different sources and one residual category. The categories are domestic and foreign financial institutions, foreign venture capitalists, private and public VCs, Sitra, Finnvera and Tekes and other governmental and public sources described above. The remaining sources are summed up in the category "Other capital loans". Table 2.7 displays the distribution by the firm size and age. We can observe in panel A that Tekes is the dominant source of capital loans in the biotech SME sector in Finland providing over 50% of the total capital loans (53.4%). Private VCs come second with 18.1% of the total and Sitra third with 13.7%. There are some capital loans provided by foreign VCs (4%). The rest of the sources contribute less than 1% each. Taking into account that Tekes, Sitra and Finnvera are public sources of funding, capital loans from the public sector constitute 67.8% of all capital loans flowing to the Finnish biotech SMEs. Panel B reveals that

Table 2.7 Distribution of capital loans by firm size and age

	Private				Public						
	Dom. fin. instit.	Foreign fin. instit.	Foreign VC	Private VC	Public VC	Sitra	Finnvera	Tekes	Other governm. & public	Other	Total
A: All (N=72)											
%	0.6 %	0.0 %	4.0 %	18.1 %	0.4 %	13.7 %	0.3 %	53.4 %	0.0 %	9.6 %	100.0 %
(amount, mill.€)											96.2
B: Breakdown by size of SME											
Small	2.5 %	0.0 %	16.9 %	18.4 %	0.0 %	37.7 %	1.4 %	19.2 %	0.0 %	4.0 %	100.0 %
(amount, mill.€)											21.7
Large	0.0 %	0.0 %	0.3 %	18.0 %	0.6 %	6.7 %	0.0 %	63.3 %	0.0 %	11.2 %	100.0 %
(amount, mill.€)											74.5
C: Breakdown by age of SME											
Infant	0.7 %	0.0 %	5.1 %	22.5 %	0.6 %	11.4 %	0.2 %	48.0 %	0.0 %	11.4 %	100.0 %
(amount, mill.€)											75.2
Adolescent	0.0 %	0.0 %	0.0 %	1.4 %	0.0 %	20.1 %	0.7 %	76.1 %	0.0 %	1.7 %	100.0 %
(amount, mill.€)											17.3
Middle-aged	0.0 %	0.0 %	0.0 %	5.4 %	0.0 %	29.9 %	0.0 %	55.4 %	0.0 %	9.3 %	100.0 %
(amount, mill.€)											3.6
Old	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
(amount, mill.€)											n.a.

among small companies Sitra is the major provider of capital loans (37.7%). Tekes surely plays a significant role, too, contributing 19.2% of the total capital loan supply. Also private and foreign VCs are important sources with 18.4% and 16.9% respectively. Altogether, capital loans from public sources dominate the supply with 58.3%, but companies draw loans to a not insignificant level from private sources as well (37.8%). For larger firms the picture changes greatly. Tekes provides a massive 63.3% of capital loans alone followed by private VCs with 18%. Sitra has lost its position as the most important provider and supplies only 6.7% of the total ranking third. The aggregate public sector supply among large firms is 70.6%.

Distributions by age in panel C show that Tekes is the dominant supplier of capital loans in every age category. Tekes provides 48% of the total capital loans of infant companies. As another governmental source Sitra provides 11.4% of capital loan funding. Again private VCs are strong with 22.5%. The aggregate supply of the public sector to the infant biotech SMEs is 60.2%. Among the adolescent the pattern changes radically. Tekes alone has a major share of 76.1% of the total capital loan provision. Sitra is the second largest provider with 20.1%. The rest is almost negligible. The public sector provides 96.9% of capital loans among the adolescent firms. For the middle-aged companies the distribution is only a little different. Tekes and Sitra still share the pie between each other with 55.4% and 29.9% respectively, although the balance between the two is more even now. Private VCs provide 5.4% of the total.

It has to be remarked that the total amount of capital loans in euros drops radically and monotonously when moving from younger companies towards the older ones.

2.3 Distributions of equity and debt by innovativeness and R&D – intensity

This section presents the distributions of equity capital loans and debt by innovations activity and the research and development intensity of the firms in the sample. A dominant characteristic of the biotech SME sector is that the major share of the total population, over 85%, is classified as highly R&D intensive firms following the definition of the benchmark study. Some 7% of the companies belong to the category “low R&D intensity” and the remaining 7% have not reported to have any R&D activities at all. This makes the sector special, especially compared to the benchmark where only 9% of the companies belong to the high R&D intensity category. It also has implications concerning the validity of the estimations of low intensity and non-R&D firms, since they are vulnerable to distortions caused by single outlying companies due to the small number of observations in the respective categories. Therefore, we urge to focus on firms with high R&D intensities.

2.3.1 Overview

In table 2.8.A we see the estimated distribution of equity, capital loans and debt by the innovation activity and R&D intensity. Panel A shows the unconditioned distribution of funding sources. Panel B displays the distribution by innovation activity. The categories “has innovated within past 3 years” and “has not innovated within past 3 years” are identical by definition to the categories “innovative firms” and “non-innovative firms” of the benchmark study. Our category titles are almost self-explanatory and include innovations in the field of products, processes or both. Over 65% of the firms in the biotech SME sector are estimated to have innovated within the past three years. The corresponding number in the benchmark is 33%. If asked whether the firms will innovate within the *next* five years, the percentage rises to an imposing 94,1%. Panel C

Table 2.8.A Estimated distribution of aggregate equity, capital loans and debt by innovation activity

	Equity	Capital loans	Debt	Total
A: All (N=72)				
%	43,6 %	31,5 %	24,9 %	100,0 %
(amount, mill.€)				305,3
B: Breakdown by whether SME has innovated within past 3 years				
Has innovated	34,1 %	26,4 %	39,5 %	100,0 %
(amount, mill.€)				126,6
Has not innovated	50,4 %	35,1 %	14,5 %	100,0 %
(amount, mill.€)				178,7
C: Breakdown by R&D intensity of SME				
High intensity	43,0 %	32,3 %	24,7 %	100,0 %
(amount, mill.€)				296,8
Low intensity	70,5 %	0,0 %	29,5 %	100,0 %
(amount, mill.€)				7,5
No R&D expenditure	44,0 %	23,7 %	32,3 %	100,0 %
(amount, mill.€)				0,9
D: Breakdown by patenting activity of SME				
Has patents	49,6 %	27,9 %	22,5 %	100,0 %
(amount, mill.€)				279,4
Has no patents	-20.8 %	70.7 %	50.1 %	100,0 %
(amount, mill.€)				31,3

is subdivided into three categories describing the R&D intensity of the biotech SMEs defined as the ratio of R&D costs to the total costs during the last fiscal period. The definition of the ratio is somewhat different from the benchmark where R&D costs are related to net sales. For our paper this definition is not very useful and would give a distorted picture, since many firms have not generated any appreciable revenue streams yet and are still in the research phase of the innovation-to-market cycle. R&D intensities would tend to be exaggerated. The total costs are a more suitable approximation for the volume of business activities. Otherwise the classification imitates the benchmark. A firm is regarded to be highly R&D intensive if the ratio is over 5%. Firms with a ratio of less than 5% in the positive range are regarded to have a low R&D intensity. Firms with no reported R&D expenses belong to the category "No R&D expenditure". In panel D firms that own patents are put into the category "Has patents" and if not, they belong to the category "Has no patents". Panel E of the benchmark study is not computed in this paper. Over 69% of firms report that they own patents. In the benchmark the equivalent number is 6%.

On the basis of panels B,C and D we can say that

- The (capital loans inclusive) debt ratio of firms that have innovated within the last three years and are highly innovative are higher than that of firms who have not innovated and display low R&D intensity. The debt ratio of highly R&D intensive firms is even somewhat higher than that of firms with no R&D expenses at all. These findings are in contradiction with the benchmark. However, firms that possess patents have a significantly lower debt ratio than those without patents. This is in line with the benchmark. As a matter of fact, equity in the category "Has no patents" is even negative.
- In firms that have completed an innovation in the past three years debt is the most important source of funding, while in firms that have not innovated compound equity ranks first. No matter how R&D intensive a firm is, equity is the most important source in all three categories.

- The higher the R&D intensity of a firm, the relatively less conventional debt it employs. Firms with patents have also less debt than firms without patents.
- Firms that have innovated within the past three years employ less capital loans than those who have not. Also, so it seems, firms with patents employ less capital loans than firms with no patents. These findings are rather unexpected since capital loans are usually given out after a careful examination of past performance and future expectations. A sensible explanation is that the categories "Has not innovated within past 3 years" and "Has no patents" include relatively large firms with great recognizable future potential but the firms are too young to have innovated or obtained patents yet.
- A comparison of the capital loan shares in the categories "High R&D intensity" vs. "No R&D intensity" supports our expectance that firms with greater R&D intensity are granted more capital loans than firms with low intensities.

Table 2.8.B Estimated distribution of aggregate equity, capital loans and debt by innovation activity (corrected for past losses)

	Equity	Capital loans	Debt	Total
A: All (N=72)				
%	55,6 %	24,8 %	19,6 %	100,0 %
(amount, mill.€)				387,1
B: Breakdown by whether SME has innovated within past 3 years				
Has innovated	52,6 %	19,0 %	28,4 %	100,0 %
(amount, mill.€)				176,1
Has not innovated	58,0 %	29,7 %	12,3 %	100,0 %
(amount, mill.€)				211,0
C: Breakdown by R&D intensity of SME				
High intensity	54,9 %	25,5 %	19,5 %	100,0 %
(amount, mill.€)				375,8
Low intensity	78,2 %	0,0 %	21,8 %	100,0 %
(amount, mill.€)				10,2
No R&D expenditure	52,3 %	20,2 %	27,6 %	100,0 %
(amount, mill.€)				1,1
D: Breakdown by patenting activity of SME				
Has patents	58,8 %	22,8 %	18,4 %	100,0 %
(amount, mill.€)				341,4
Has no patents	31,5 %	40,1 %	28,4 %	100,0 %
(amount, mill.€)				45,7

Table 2.8.B shows again the same distributions as table 3.8.A but is computed with equity that is corrected for losses of previous periods. Although corrected for losses, the findings of the table reveal the same patterns as table A.

Table 2.8.C is again directly comparable to the table 3.7 in the benchmark study. We caution anew that equity shares in this table are higher than in reality due to the correction for past losses. In summary, the findings of table 2.8.C reveal that

- for firms that have innovated in the past three years, firms with high R&D intensity and firms with patents the single most important source of funding is "Other equity", which contradicts the benchmark, where the equivalent source is the principal owner's equity.
- In conformity with the benchmark, firms with high R&D intensities have a lower debt ratio than firms that have innovated in the past three years.

Table 2.8.C Estimated distributions of equity, capital loans and debt by innovation activity

	Sources of equity			Capital loans		Sources of debt					
	Principal owner	Other equity	Total equity	Private	Public	Total cap. loans	Financial instit.	Other instit.	Other debt	Total debt	Total debt and equity
A: All (N=72)											
%	12,9 %	41,5 %	54,5 %	9,8 %	16,5 %	26,3 %	3,4 %	5,7 %	10,1 %	19,2 %	100,0 %
(amount, mill.€)											394,7
B: Breakdown by whether SME has innovated within past 3 years											
Has innovated	22,8 %	27,6 %	50,4 %	14,6 %	7,7 %	22,4 %	6,8 %	7,1 %	13,2 %	27,2 %	100,0 %
(amount, mill.€)											183,8
Has not innovated	4,3 %	53,7 %	58,0 %	5,6 %	24,2 %	29,7 %	0,4 %	4,5 %	7,4 %	12,3 %	100,0 %
(amount, mill.€)											211,0
C: Breakdown by R&D intensity of SME											
High intensity	11,6 %	43,3 %	54,9 %	8,2 %	17,3 %	25,5 %	3,6 %	6,0 %	10,0 %	19,5 %	100,0 %
(amount, mill.€)											375,8
Low intensity	39,7 %	5,1 %	44,7 %	42,8 %	0,0 %	42,8 %	0,5 %	0,0 %	12,0 %	12,5 %	100,0 %
(amount, mill.€)											17,9
No R&D expenditure	29,6 %	22,6 %	52,3 %	0,0 %	20,2 %	20,2 %	0,0 %	0,0 %	27,5 %	27,6 %	100,0 %
(amount, mill.€)											1,1
D: Breakdown by patenting activity of SME											
Has patents	13,9 %	43,6 %	57,5 %	8,0 %	16,5 %	24,5 %	2,4 %	5,5 %	10,2 %	18,0 %	100,0 %
(amount, mill.€)											349,1
Has no patents	5,7 %	25,8 %	31,5 %	23,6 %	16,5 %	40,1 %	11,4 %	7,3 %	9,7 %	28,4 %	100,0 %
(amount, mill.€)											45,7

2.3.2 Sources of equity

Table 2.9 Estimated distribution of equity by innovation activity

		Individuals		Institutions					
	Principal owner	Managers & empl.	Other individ.	Public vc	Private vc	Financial instit.	Other firms	Other equity	Total sources of equity
A: All (N=72)									
%	23,7 %	21,3 %	5,2 %	16,1 %	23,4 %	2,2 %	7,0 %	1,2 %	100,0 %
(amount, mill.€)									215,1
B: Breakdown by whether SME has innovated within past 3 years									
Has innovated	45,3 %	17,6 %	4,1 %	4,4 %	11,1 %	0,6 %	16,2 %	0,7 %	100,0 %
(amount, mill.€)									92,7
Has not innovated	7,4 %	24,1 %	6,0 %	25,0 %	32,7 %	3,4 %	0,0 %	1,5 %	100,0 %
(amount, mill.€)									122,4
C: Breakdown by R&D intensity of SME									
High intensity	21,1 %	22,1 %	5,4 %	16,6 %	24,3 %	2,2 %	7,2 %	1,2 %	100,0 %
(amount, mill.€)									206,6
Low intensity	88,7 %	0,1 %	0,1 %	2,4 %	2,5 %	2,4 %	3,1 %	0,7 %	100,0 %
(amount, mill.€)									8,0
No R&D expenditure	56,7 %	22,6 %	0,1 %	20,6 %	0,0 %	0,0 %	0,0 %	0,0 %	100,0 %
(amount, mill.€)									0,6
D: Breakdown by patenting activity of SME									
Has patents	24,1 %	19,8 %	3,9 %	16,7 %	25,0 %	2,3 %	7,1 %	1,1 %	100,0 %
(amount, mill.€)									200,7
Has no patents	18,2 %	42,3 %	23,0 %	7,3 %	1,3 %	0,9 %	5,3 %	1,7 %	100,0 %
(amount, mill.€)									14,4

Table 2.10 Estimated distribution of equity (principal owner disaggregated) by innovation activity

	Individuals		Institutions					
	Active in business	Other individ.	Public VC	Private VC	Financial instit.	Other firms	Other equity	Total sources of equity
A: All (N=72)								
%	22,8 %	5,2 %	19,4 %	24,3 %	2,2 %	22,0 %	4,2 %	100,0 %
(amount, mill.€)								215,1
B: Breakdown by whether SME has innovated within past 3 years								
Has innovated	20,4 %	4,1 %	11,5 %	12,4 %	0,6 %	43,2 %	7,8 %	100,0 %
(amount, mill.€)								92,7
Has not innovated	24,6 %	6,0 %	25,3 %	33,2 %	3,4 %	6,0 %	1,5 %	100,0 %
(amount, mill.€)								122,4
C: Breakdown by R&D intensity of SME								
High intensity	23,5 %	5,4 %	20,0 %	25,2 %	2,2 %	19,4 %	4,4 %	100,0 %
(amount, mill.€)								206,5
Low intensity	2,9 %	0,1 %	2,4 %	2,5 %	2,4 %	88,9 %	0,7 %	100,0 %
(amount, mill.€)								8,0
No R&D expenditure	51,8 %	0,1 %	20,6 %	0,0 %	0,0 %	27,5 %	0,0 %	100,0 %
(amount, mill.€)								0,6
D: Breakdown by patenting activity of SME								
Has patents	21,1 %	3,9 %	20,0 %	25,9 %	2,3 %	22,4 %	4,4 %	100,0 %
(amount, mill.€)								200,7
Has no patents	45,6 %	23,0 %	10,3 %	1,3 %	0,9 %	17,2 %	1,7 %	100,0 %
(amount, mill.€)								14,4

Tables 2.9 – 2.11 give more detailed insight into the distribution of equity by innovation activity and R&D intensity. From tables 2.9 and 2.10 we can see that

- Biotech SMEs rely more on broad and narrow inside equity when they have no R&D expenses as compared to high intensity firms. This is in strict contradiction with the benchmark. Low R&D intensity firms constitute a peak in broad inside equity with 88.8%. At the same time their narrow inside equity is the lowest of all three R&D intensity categories, since equity here stems mainly from "Other firms". This insinuates that the principle owner of low intensity firms are other companies. This could mean that these low intensity firms are subsidiaries of corporations that perform functions other than research and development, which would explain the low R&D intensity. Again, we have to keep in mind that these estimates may well be inaccurate due to the small representation in the category.
- In agreement with the benchmark, the most important sources of outside equity for highly R&D intensive firms are venture capital and other non-financial firms. It should be pointed out that not only is venture capital the most important for outside equity but the most important source of total equity. This holds true for firms with patents, too.
- For high intensity firms, firms with patents and firms that have *not* innovated in the past three years private venture capitalists are the most important single source of equity. The seeming discrepancy related to the latter firms can be explained again by the fact that the category includes young firms with great future potential. A firm with no previous innovations can very well be highly R&D intensive. For firms that have innovated in the last three years it is "other firms" that provide most of the total equity.

Table 2.11 Estimated distribution of principal owner's equity by innovation activity

	Individuals		Institutions			
	Active in business	Other individ.	Venture Capital	Other firms	Other instit.	Total principal owner
A: All (N=72)						
%	6,3 %	0,0 %	17,5 %	63,4 %	12,8 %	100,0 %
(amount, mill.€)						51,0
B: Breakdown by whether SME has innovated within past 3 years						
Has innovated	6,1 %	0,0 %	18,6 %	59,7 %	15,6 %	100,0 %
(amount, mill.€)						41,9
Has not innovated	7,1 %	0,0 %	12,3 %	80,6 %	0,0 %	100,0 %
(amount, mill.€)						9,1
C: Breakdown by R&D intensity of SME						
High intensity	6,4 %	0,0 %	20,5 %	58,1 %	15,0 %	100,0 %
(amount, mill.€)						43,6
Low intensity	3,3 %	0,0 %	0,0 %	96,7 %	0,0 %	100,0 %
(amount, mill.€)						7,1
No R&D expenditure	51,5 %	0,0 %	0,0 %	48,5 %	0,0 %	100,0 %
(amount, mill.€)						0,3
D: Breakdown by patenting activity of SME						
Has patents	5,6 %	0,0 %	17,6 %	63,3 %	13,5 %	100,0 %
(amount, mill.€)						48,4
Has no patents	18,1 %	0,0 %	16,3 %	65,5 %	0,0 %	100,0 %
(amount, mill.€)						2,6

In strong contrast to the benchmark, table 2.11 reveals that no matter in which category we look, other firms always dominate as principal owners. The only exception can be found in the category “No R&D expenses” where those active in the business marginally provide more principal owner’s equity than other firms.

2.3.3 Sources of debt

Panel B of table 2.12 discloses that firms that have innovated in the last three-year period rely on a broader source base for debt financing than their non-innovative counterparts. There is a fair balance between debt financing from diverse financial institutions (a compound 24.9%), non-financial and governmental sources (26.1%) and trade credit (26.5%). Other debt constitutes another 22.3% of total debt. It seems obvious that firms that have been innovative in the past three years are able to draw funds from more numerous sources than non-innovative firms, especially from the financial institutions. One plausible explanation is that the innovative firms are able to present products/services which have a higher likelihood to create revenue streams in the close future since innovations have already exited the research phase of the product-to-market cycle. Non-innovative firms still find themselves in the research phase and are therefore riskier debtors. They are backed by governmental creditors, particularly Tekes (25%). Conventional debt is issued by financial institutions only marginally (3.6%). As a specialized institution for technology R&D funding, Tekes has the ability to identify potential at a very early stage. This could explain Tekes’ relatively large share of debt provision. It has to be highlighted that firms that have not innovated in the prior three year period display a rather large trade credit percentage. This might indicate a generally low debt ratio, which is confirmed by table 2.8.A.

Table 2.12 Estimated distribution of debt by innovation activity

	Financial institutions				Nonfinancial business and government							
	Domestic banks	Domestic finance firms	Other dom. fin. instit.	Foreign fin. instit.	Trade credit	Other nonfin. Business	Finnvera	Tekes	Other govt.	CPs and bonds	Other debt	Total sources of debt
A: All (N=72)												
%	14.5 %	3.2 %	0.0 %	0.0 %	31.8 %	5.5 %	6.5 %	13.3 %	4.4 %	0.4 %	20.4 %	100.0 %
(amount, mill.€)												75.9
B: Breakdown by whether SME has innovated within past 3 years												
Has innovated	21.0 %	3.9 %	0.0 %	0.0 %	26.5 %	6.8 %	9.5 %	7.2 %	2.6 %	0.0 %	22.3 %	100.0 %
(amount, mill.€)												50.0
Has not innovated	1.9 %	1.7 %	0.0 %	0.0 %	41.9 %	2.9 %	0.6 %	25.0 %	7.9 %	1.3 %	16.8 %	100.0 %
(amount, mill.€)												25.9
C: Breakdown by R&D intensity of SME												
High intensity	14.9 %	3.3 %	0.0 %	0.0 %	31.4 %	5.7 %	6.7 %	13.7 %	4.6 %	0.5 %	19.2 %	100.0 %
(amount, mill.€)												73.4
Low intensity	3.4 %	0.1 %	0.1 %	0.0 %	45.6 %	0.0 %	0.1 %	0.0 %	0.0 %	0.0 %	50.6 %	100.0 %
(amount, mill.€)												2.2
No R&D expenditure	0.0 %	0.0 %	0.1 %	0.0 %	10.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	89.9 %	100.0 %
(amount, mill.€)												0.3
D: Breakdown by patenting activity of SME												
Has patents	11.1 %	1.9 %	0.0 %	0.0 %	34.9 %	6.2 %	5.2 %	15.3 %	3.8 %	0.5 %	21.1 %	100.0 %
(amount, mill.€)												62.9
Has no patents	30.9 %	9.3 %	0.2 %	0.0 %	16.8 %	2.0 %	12.9 %	3.4 %	7.3 %	0.0 %	17.3 %	100.0 %
(amount, mill.€)												13.0

Panel C supports the findings of panel B in the sense that firms with strong ambitions concerning innovative activity do receive debt money from a larger variety of sources. The distribution resembles strongly that of the whole sample due to the fact that only 10 firms fall outside the "high intensity" category. It is interesting to observe that firms with either low or non-existent R&D –ratios do not receive any debt financing from Tekes or other governmental sources. These firms mainly rely on "other debt" and trade credit, which in this case is not a sign of a generally low debt ratio as can be seen in table 2.8.A.

Panel D gives us a less clear-cut picture. Firms in both categories, "Has patents" and "Has no patents", receive debt financing from a broad variety of sources. Tekes provides a larger share of total debt in the category "Has patents" (15.3% vs. 3.4%), which is not surprising. It can also be said that having innovated within the past three years does not mean that those firms also own patents, meaning that those two proxies, against normal intuition, do not express equivalent phenomena. Against expectations, firms without patents draw just over 40% of their debt from financial institutions. The equivalent figure of firms owning patents is just 13%. Firms without patents rely relatively less on non-financial and governmental creditors than their rivals owning patents (25.6% vs. 30.5%). Firms with patents display a larger share of trade credit than their counterparts (34.9% vs. 16.8%). Although the picture looks unexpected on the first glimpse, it is not unexplainable after short reflection. Tables 2.8.A and B show that firms that own patents have a far stronger capital ratio than firms without patents. Without being corrected for past losses the ratio for non-patent firms is even negative. Their conventional and capital loans inclusive debt ratio is far higher. Thus, it could be that firms owning patents are able to create revenue streams on the basis of their patents and are older, established companies operating more heavily on revenue income finance. These firms do not have to resort to debt finance to such an extent as their non-profitable rivals.

2.3.4 Distribution of capital loans

Table 2.13 shows the distribution of capital loans by innovation activity of firms. Together with the information of panel B and table 2.8.A one can infer that firms that have innovated in the last three years have less capital loans than their counterparts and draw it mainly from private venture capitalists (42.8%). Firms that cannot present patents from the prior three year period draw the major share of total capital loans from Tekes (68.3%). Again it is obvious that category "Has not innovated" includes highly potential firms with strong future prospects, but cannot show any concrete research results yet. Firms that have innovated have earned the trust of the private sector and are able to get financing from these sources, even from abroad (10.9%). Still, capital loans from Sitra and Tekes together constitute the lion's share of total capital loans with a combined 41.6%.

Very much in accordance with intuition, panel C shows that firms outside the "high intensity" category receive next to no capital loans. The distribution of capital loans of the "high intensity" category matches that of the total sample almost perfectly. Firms that do not promise positive future perspectives by investing into R&D receive almost no capital loans, and if they do, the source is governmental (more exactly Sitra & Tekes).

From panel D we can see that firms owning patents receive 61.7% of their capital loans from Tekes. The major source of capital loans for firms that do not have patents is private venture capitalists (58.8%). They also receive capital loans from Sitra (20.2%) and Tekes (17.7%) to a significant extent.

Table 2.13 Distribution of capital loans by innovation activity

	Private				Public						
	Dom. fin. instit.	Foreign fin. instit.	Foreign VC	Private VC	Public VC	Sitra	Finnvera	Tekes	Other governm. & public	Other	Total
A: All (N=72)											
%	0.6 %	0.0 %	4.0 %	18.1 %	0.4 %	13.7 %	0.3 %	53.4 %	0.0 %	9.6 %	100.0 %
(amount, mill.€)											96.2
B: Breakdown by whether SME has innovated within past 3 years											
Has innovated	1.6 %	0.0 %	10.9 %	42.8 %	0.0 %	16.2 %	0.9 %	25.4 %	0.0 %	2.2 %	100.0 %
(amount, mill.€)											33.5
Has not innovated	0.0 %	0.0 %	0.3 %	4.9 %	0.7 %	12.3 %	0.0 %	68.3 %	0.0 %	13.5 %	100.0 %
(amount, mill.€)											62.7
C: Breakdown by R&D intensity of SME											
High intensity	0.6 %	0.0 %	4.0 %	18.1 %	0.4 %	13.6 %	0.3 %	53.3 %	0.0 %	9.6 %	100.0 %
(amount, mill.€)											95.9
Low intensity	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
(amount, mill.€)											0.000
No R&D expenditure	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	25.0 %	0.0 %	75.0 %	0.0 %	0.0 %	100.0 %
(amount, mill.€)											0.2
D: Breakdown by patenting activity of SME											
Has patents	0.7 %	0.0 %	5.0 %	8.5 %	0.0 %	12.1 %	0.2 %	61.7 %	0.0 %	11.8 %	100.0 %
(amount, mill.€)											77.9
Has no patents	0.0 %	0.0 %	0.0 %	58.8 %	2.4 %	20.2 %	1.0 %	17.7 %	0.0 %	0.0 %	100.0 %
(amount, mill.€)											18.3

3 Interdependence of business performance and the sources of finance

3.1 Introduction

The discussion above dealt with the question who had financed Finnish biotechnology firms and which financing instruments they had used. The sources of finance were compared with the sources of finance in Finnish SMEs as a whole. The comprehensive study was performed by tabulating some background variables with the percentage shares of the financing sources. Financing sources were mirrored to some rough measures of sizes, R&D intensities and innovativeness of the companies. However, this view raises some questions about the linkages between the different types of firms.

The aim of this part of the study is to specify the linkages between the sources of finance and the general features of the biotech industry in order to construct guidelines for further research. We utilize variables measuring the same subjects as in the previous section above and conclude how the findings may be contrasted to the finance literature. In other words, our method contrasts the form of conventional quantitative research in two respects.

There are not many empirical studies that cover the entire biotech sector in Finland. Therefore, we rely also in this part on the explorative approach. In other words, there is no theoretical framework beyond the empirical investigation. We employ principal component analysis (PCA) as a statistical tool. This method is based on the idea of not dealing with theoretical or other preconditions. PCA compresses the multitude of variables to a few components by exploiting the variation between cases. The variables are loaded with the component resulted from the analysis. Accordingly, our methodological goal is to find the components which link together the sources-of-finance and general-features variables from the data of biotech SMEs.

We chose the PCA method instead of correlation method. The PCA method is a more powerful tool than simple correlation measures because PCA can partition common variances in data. Correlation tables measure the linkages (common variance) between variables. Due to the contradictions between different groups within data, the correlation method sometimes destroys part of the information a sample contains, which PCA takes into account.

3.2 Variables

Variables are selected by grouping them into two main parts. In the first group, there are 12 variables depicting present economic performance, innovation intensity, and the quality of the labor of the firms. These 8 variables measure economic performance and other present features of firms and the rest of the 4 variables depict innovation capacity and activities. The second group consists of 12 variables, as well, presenting the sources of corporate finance. Some 7 variables measure private sources of finance and 5 variables capture public sector sources of finance and support. Direct expectations of the firms are taken into account by a single variable ”anticipated growth rate of sales”. (See table below).

Table 3.1. List of variables used in principal component analysis.

Name of group	Name of variable	Measure
Economic performance	Volume of commercial activities	Biotech turnover
	Volume of total activities	Number of personnel
	Total turnover per persons employed	Total turnover per persons employed
	Profitability	Profits per turnover
	Exports intensity	Exports per sales
	Age of firm	Age in years
	Solidity	Equity per (equity + debt)
Innovation activities and personnel skills	R&D intensity	R&D costs per total costs
	Commercialization ability	Biotech turnover per (1+ patent applications + patents)
	Innovation intensity	Patent applications per R&D personnel
	Business experience of CEO	Years in business life of CEO
	Skilled labor intensity	Research trained persons per total personnel
Private sources of finance	Influence of principal owner	Equity share of principal owner
	Individuals active in business as an owner	Equity share of individuals active in business
	Subsidiary effect	Equity share of other non-financial firms
	Private venture capitalist as an owner	Equity share of private venture capitalist
	Private capital loan intensity	Private capital loan share
	Debt from private financial institutions	Debt share of private financial institutions
	Trade credit intensity	Debt share of trade credit
Public sources of finance	Public venture capitalist as an owner	Equity share of public venture capitalist
	Public capital loan intensity	Public debt per total debt
	Public debt intensity	Public debt per total debt
	Public R&D finance intensity	Public R&D support per R&D costs of a firm
	Public R&D support usage	Share of public R&D support paid to academic institutions by firms
Expectations	Anticipated growth of sales	Anticipated annual growth rate of turnover in next 5 years

3.3 Results and discussion

The PCA method offered 9 principal components from which we also employed in order to explain the interconnectedness of the structures of financing sources and the general features of the small and medium-sized biotech companies. [15] PCA was performed with a different number of variables. The results seemed relatively robust. Although the order of components altered among the last ones, the variables loaded strongly within the components remained mainly the same. We also employed rotated principal component matrix solutions in order to ensure the sufficient loadings within the last ordered components, too.

The PCA model explained 72 percent out of the total variation for the data (Appendix 2, Table "Total variance explained"). The model explains over 50 percent of the variation on the original variables: the communalities of the single variables are in the range 0.55-0.90 (Appendix 2, Communalities).

The principal components obtained from the analysis can be divided to two fragments. The first fragment contains 3 general components reflecting the general features of the biotech firms. The second fragment is composed of 6 components related mainly to the sources of equity finance. Other forms of finance are also observed in this context.[16]

[15] The general idea principal component analysis (PCA) is shortly expressed in appendix 1.
[16] Principal component statistics and component loading matrices are presented in appendix 2.

Table 3.2. General components of the Finnish small and medium-sized biotech firms

”R&D intensity” component	”Public R&D funding” component	”Experienced CEO” component
- High R&D intensity - High growth prospects - High share of debt from public sector - Small company, low biotech turnover - Young - Low current commercialization ability - Low turnover per amount of labor	- High public R&D supports - High share of public R&D support paid to academic collaboration -Low equity share of principal owners	- Manager’s long business experience - Relatively old firm - High biotech turnover - Large amount of labor - High exports intensity - Large share of public R&D support paid to academic collaboration

The general components describe the main features of the biotech companies. The features of the components are mentioned through adjectives, e.g. ”Small and young company with high R&D intensity”. The component structure can also be characterized by the opposite expression: ”A large and old company with low R&D intensity”.

The R&D intensity component describes some features which have conventionally been linked as common to the new biotech companies. The component presents how R&D intensity is related to the company’s age and size. High R&D intensity is loaded together with the company’s low turnover and young age in the component. Simultaneously low actual commercialization ability is linked with high growth prospects. In other words, the anticipated growth is not based on the already realized commercialization ability but it is based on the ability in the future. R&D intensity is not loaded with any particular ownership structure. This seems to be in line with the empirical finding that high-tech firms utilize internal finance when they acquire new technology through R&D (Himmelberg and Petersen 1994).

Public R&D support varies together with the Academic R&D collaboration within the ”Public R&D funding” component. This is because the public authorities oblige the firm supported to collaborate with external research institutions. For example, Tekes (The National Technology Agency) demands often the existence of a collaboration network before financing any research project. Klette, Møen and Griliches (2000) discuss about the spill-over effects in R&D activities subsidized by a government. Furthermore, the equity share of the principal owners is negatively loaded with the amount of public R&D support within this component. In other words, a part of the publicly supported companies are not controlled by influential owners with high shares of equity.

Management competence is measured simply by the CEO’s business experience in years. The business experience of the CEO seems to be a general feature within a part of the sample and it is not related to the sources of finance. The experienced CEO works in a relatively old and large company with high export intensity. The CEO also seems to notice the collaboration with academic research institutions.

Table 3.3. Owner-based components

"Innovative subsidiaries" component	**"Large subsidiaries" component**
- High equity share of principal owners - High equity share of other companies - High innovation intensity - High biotech turnover - High turnover per amount of labor - High debt share of trade credit - Low share of debt from public sector	- High equity share of other companies - Large amount of personnel - High biotech turnover - Low share of post-graduate personnel
"Owners active in business" component	**"Public sector VC* as an owner with high growth prospects" component**
- High equity share of individuals active in business - High share of post-graduate personnel - Small amount of personnel - Small biotech turnover	- High equity share of public sector venture capitalist - High anticipated growth rate of turnover - High solidity - High debt share of trade credit - High share of capital loans from public authorities - Relatively young companies - Small amount of personnel - Low equity share of principal owners - Low equity share of individuals active in business
"Private VC* company as an owner with high growth prospects" component	**"High R&D intensity and Private VC* company as an owner" component**
- High equity share of private venture capitalist companies - High anticipated growth rate of turnover - High share of debt from domestic financial institutions - Low equity share of principal owners - Low share capital loans from public authorities	- High equity share of private venture capitalist companies - High R&D intensity - High share of public debt - Low current profitability - Low current exports intensity - Low commercialization ability

**VC stands for Venture Capitalist.*

The literature of ownership structure puts relatively much emphasis on agency costs (see Jensen and Meckling 1976; Fama and Jensen 1983; Bergström and Rydqvist 1991; Ang, Cole and Wuh Lin 2000). That is, how the manager uses the owner's funds and how the owner can control the manager's behavior. The interaction affects agency costs. The agency costs are higher when the firm is financed by outside equity, and the agency costs can be reduced when the owners work in the company (see the "owners active in business" component). The "owners active in business" component is the mirror image of the large subsidiaries component above. There is a large personnel share of research trained staff.[17]

[17] Research trained staff contains the personnel which hold a post-graduate degree. That is to say, they hold a doctor's or licentiate degree.

Two components capture high loadings with the equity share of other non-financial companies. These are called here subsidiary components. They show that parent companies invest in the subsidiaries with the actualized growth of sales. The innovative subsidiaries component indicates that there are some other-firm-owned companies with relatively high biotech turnover and with high innovation intensity. May it be reminded that Innovation intensity is the number of patents and patent applications relative to the number of personnel in R&D activities. The outside non-financial firms seem to evaluate the codified knowledge, such as e.g. patent applications and patents (see the innovation subsidiaries in the table 3.3). Lerner, Shane and Tsai (2002) see information asymmetries as a focal driver for small biotechnology firms to rely on large firms as a principal owner. As investors in finance markets may not have specialized knowledge to finance biotech firms, large firms may have such knowledge.

Another "subsidiary firm" component simply relates the equity share of the parent company to the size of a subsidiary firm (measured both as in sales volume and the amount of personnel). A small R&D intensity (within the component) may be explained by the organizational division of activities within multi-functional consolidations. R&D activities, sales, and production may be partially organized in separate divisions within the kind of consolidation. This kind of internal division of activities could explain the seemingly low R&D intensity loadings.

Two components have high loadings with the equity share of private venture capital companies. These two components imply interesting relations to other financing instruments. The "private VC and high growth prospects" component presents how the equity share of private VC's is varying jointly with the debt share of domestic and private financial institutions (e.g. banks). The "high R&D intensity and private VC" component shows how high private VC investments are related to the relatively high share of public debt. This may be due to the wide monitoring ability of private VCs or private and public debtors. PCA does not tell anything about the causality within the components. Pecking order theory (Myers 1984, 2001) suggests that the financial institutions have first announced a debt to some biotechnology firms and then private VCs have invested some equity finance in them. A partially reversed pecking order (see Hyytinen and Pajarinen 2002) implies that VCs have been first investors before banks and other financial institutions. The latter hypothesis seems more plausible in the context of Finnish Biotechnology SMEs. This can also be seen in the table 2.4. In addition, Bhagat and Welch (1995) show that R&D intensity and debt ratio vary in different manners in the international comparison. Baysinger, Kosnik and Turk (1991) relate the large equity share owned by institutional investors to high R&D intensity among large public companies in the US. Hence, it would be important to find systematic features behind this relation.

The "private VC and growth prospect" component raises some questions. Why are the growth prospects of the firms not related to any substantial activities (e.g. R&D intensity) or skill inventories (e.g. education of personnel)? Why is the anticipated growth of sales only related to the structures of financing sources? A search for an explanation is possibly two-sided. First, the private VCs can hold knowledge and monitoring ability that cannot be revealed from the general quantitative data. The other side of the matter could be a strict demand for high growth rates which in turn produce counter-cyclically high revealed growth rates in expected earnings. According to Harris and Ravivin (1991), high solidity, that is low leverage, implies high growth rates, as shown also by the "private VC and growth prospect" component.

The "public sector VC and high growth prospects" component also points out the relation between the equity source and growth expectations. Furthermore, public VCs

(mainly Sitra) seems to have invested in the young and small companies. Their equity finance goes jointly with their capital loan finance. Due to this financing method the companies' solvency ratios are high. This component reflects the negatively correlated relation between the public finance intensity and equity share of principal owners. Public sector has not been willing to finance companies with a high share of equity owned by individual entrepreneurs.

4 Conclusions

The first part of the study comprises the structures of finance sources utilized by small biotech businesses and the entire population of SMEs in Finland. The structures of finance are contrasted with the sizes and ages of the firms. The nature of business activities differs from each other in the biotech industry and entire economy.

Some biotech firms are highly R&D intensive and their actual sales volumes are relatively low. Many firms have made negative profits due to that. But the high growth prospects of the industry have encouraged investors to continue financing risky research activities that will create earnings in years to come. The most noticeable owners are individuals active in business (the largest share of equity investments among small companies), private venture capitalist companies (large and in infant companies), public venture capitalists (adolescent companies), and other non-financial firms (middle-aged companies). The same sources of equity finance made the largest share of investments in highly R&D intensive firms.

In practice, great losses have been compensated by the investing part of the fund as capital loans. This enables equity to be positive in the total balance sheet. This also offers a risk-sharing tool to an investor. However, the interest rates for capital loans are usually higher than the rates of conventional loans, and the contracts include an option to exchange the capital loan for the company's stocks on the expiring date of the capital loan. The capital loan instrument is much more common among the biotechnology firms than in the entire economy as a finance source.

The general view of the data expresses three bundles of characteristics. These bundles are not related to any specific ownership structures. First, some of the most R&D intensive firms seem to be recently established and they have a small amount of sales of biotechnology services or products. The R&D intensive firms announced that the more their costs contained R&D expenses, the higher their growth prospects were. Second, Public R&D finance seems to be related to the spending on academic research collaboration. This might be the result of preconditions of public sector R&D support decisions. Some public authorities demand firms to have external collaboration with academic institutions. Third, the CEO's experience is related to some features of business activities. An experienced CEO works in a mature company with large number of personnel and sales. International trade relations also seem to be subject to demand for long business experience of CEO.

The general view implied strong links between companies' intellectual capital and anticipated growth rates only in the "R&D intensity" component. The low realized commercialization ability of the young (but not necessarily small in personnel) company is related to high growth prospects. The ownership structure is also related in some respects to the high level of the anticipated growth rates of sales. Especially the companies that were owned or capital loan financed by private or public VCs announced high

growth prospects in their sales volumes. This raises a need of further research to investigate what kind of systematic explanations there are for the companies' growth expectations in the Finnish biotech industry.

This research can be extended according to the literature references in the text above. The three main paths for further research could be the following. First, the pecking-order theory – that illustrates how internal finance precedes debt finance, which in turn precedes external equity finance (Myers and Majluf 1984; Myers 1984). The theory deals with the company insiders and outside investors. According to the theory, firms attempt to minimize the finance costs by preferring first internal finance to external. If external finance is needed, the firm issues next external debt and lastly external equity. The finance cycle can be tested using data on Finnish biotechnology companies. The simple results indicate that private and public venture capitalists finance biotechnology firms in their early stages, partially contradictory to the conventional pecking-order hypothesis, but according to Hyytinen and Pajarinen (2002).

A second relevant research path could be found in the framework of trade-off theory. The theory deals with the optimal level of debt finance. Debt interest is affordable to a certain limit due to tax advantages. Accordingly, the firms with higher profits borrow less than others. Thirdly, the free-cash-flow and agency costs-related models (Jensen 1986) could offer a plausible theoretical framework for the deeper analysis of finance structures of Finnish biotechnology firms. These models fit well with firms that have a large amount of internal finance available. The same theme can be related also to the growth options literature (e.g. Garner, Nam and Ottoo 2002), which deals with the connection between the R&D intensity and market value of the firm.

Summa summarum, the study at hand described the financial aspects of biotechnology SMEs in Finland using data from the ETLA biotech survey. The study also aimed to offer a descriptive tool for planning and conducting some further research in the biotech finance analysis.

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Appendix 1: Short expression of Principal Component Analysis (PCA).

The PCA method forms as many linear combinations as there are variables (see e.g. Sharma 1996). However, we restrict the number of linear combinations to the number of components, p. The p^{th} component is the last one of which the eigenvalue is more than one. Presenting formally:

$$\begin{aligned}
\xi_1 &= w_{11}x_1 + w_{12}x_2 + \ldots + w_{1\ 25}x_{25} \\
\xi_2 &= w_{21}x_1 + w_{22}x_2 + \ldots + w_{2\ 25}x_{25} \\
&\vdots \\
\xi_p &= w_{p1}x_1 + w_{p2}x_2 + \ldots + w_{p\ 25}x_{25}
\end{aligned} \qquad \text{(A1)}$$

The components are uncorrelated within each other. The first component accounts for the maximum variance in the data and the second one accounts the variance not captured by the first component, and so on.

It is necessary to restrict the growth of variance of a single component by fixing the scale of weights. Then there is no limitation to add new variables and compare the results. Formally speaking, the sum of the squares of the weights within a component always equals one:

$$w_{i1}x_1 + w_{i2}x_2 + \ldots + w_{i\ 25}x_{25} = 1, \quad \mathrm{i} = 1, \ldots p \qquad \text{(A2)}$$

and

$$w_{i1}w_{j1} + w_{i2}w_{j2} + \ldots + w_{i\ 25}w_{j\ 25} = 0, \quad \text{for all } i \neq j. \qquad \text{(A3)}$$

In other words, the new linear combinations are orthogonal to each other and they are uncorrelated with each other.

Appendix 2. Correlation matrix.

	Biotech turnover in meuros	personnel	total turnover per labor	profitability (profits per turnover)	innovation intensity (patent applications per r&d labor)	commercialization ability (turnover per (1+patent applications+patents))	post-graduated labor per total labor	r&d costs per total costs	public r&d support per r&d costs	Solidity (equity+caploans per equity+debt)	principal owner share of equity	share of equity active in business	Other firms' equity share	public debt per total debt	debt share of domestic private financial institutions	debt share of trade credit	exports per turnover	Anticipated annual growth rate of turnover	Manager's business experience in years	Public venture capitalists' equity share	equity share of private venture capitalist	private capital loans per eq+cl	public capital loans per eq+cl	age of firm	share of public r&d support used in university research
biotech turnover in meuros	1.00	**0.87**	**0.34**	0.04	-0.04	**0.42**	-0.14	-0.17	-0.09	-0.11	-0.13	-0.15	0.25	-0.10	-0.04	0.09	-0.01	-0.11	0.22	-0.08	-0.06	-0.06	-0.11	**0.57**	0.17
personnel	0.87	1.00	**0.29**	0.04	-0.05	**0.32**	-0.22	-0.20	-0.13	-0.15	-0.17	-0.24	**0.35**	-0.13	-0.04	0.04	0.03	-0.15	0.25	-0.12	-0.09	-0.09	-0.16	**0.70**	0.26
total turnover per labor	**0.34**	**0.29**	1.00	0.18	0.11	**0.45**	-0.13	**-0.39**	-0.28	0.01	0.22	-0.21	**0.33**	-0.30	-0.02	**0.36**	0.14	**-0.23**	0.19	-0.16	-0.18	-0.10	**-0.32**	**0.35**	-0.09
profitability (profits per turnover)	0.04	0.04	0.18	1.00	0.04	0.04	0.00	**-0.30**	-0.02	-0.11	0.20	0.11	0.10	**-0.38**	0.12	0.16	0.21	-0.03	0.04	-0.22	**-0.37**	0.06	-0.02	0.11	-0.10
innovation intensity (patent applications per r&d labor)	-0.04	-0.05	0.11	0.04	1.00	-0.07	0.07	0.09	0.05	0.03	0.16	0.01	0.08	-0.14	-0.09	**0.36**	0.03	-0.04	-0.01	-0.14	-0.10	0.07	-0.05	-0.08	0.14
commercialization ability (turnover per (1+patent applications+patents))	**0.42**	**0.32**	**0.45**	0.04	-0.07	1.00	-0.14	-0.20	-0.12	0.00	0.10	-0.19	0.29	-0.13	-0.06	0.14	0.13	-0.12	0.14	-0.08	-0.08	-0.07	-0.11	0.19	-0.01
post-graduated labor per total labor	-0.14	-0.22	-0.13	0.00	0.07	-0.14	1.00	0.16	0.01	0.09	0.09	**0.50**	**-0.39**	-0.14	-0.15	0.24	-0.16	-0.03	-0.17	-0.02	0.01	0.05	-0.08	-0.27	**-0.24**
r&d costs per total costs	-0.17	-0.20	**-0.39**	**-0.30**	0.09	-0.20	0.16	1.00	0.21	-0.05	-0.17	0.14	-0.18	**0.36**	-0.15	-0.05	-0.05	**0.36**	-0.05	0.06	0.16	0.17	0.25	**-0.30**	-0.04
public r&d support per r&d costs	-0.09	-0.13	-0.28	-0.02	0.05	-0.12	0.01	0.21	1.00	0.08	-0.21	-0.10	-0.22	0.08	0.19	-0.15	-0.06	0.11	0.03	0.13	-0.04	0.15	0.25	-0.23	0.23
Solidity (equity+caploans per equity+debt)	-0.11	-0.15	0.01	-0.11	0.03	0.00	0.09	-0.05	0.08	1.00	-0.01	0.02	-0.05	-0.07	-0.24	0.23	-0.06	0.04	0.04	0.13	0.00	-0.19	0.09	0.02	0.02
principal owner share of equity	-0.13	-0.17	0.22	0.20	0.16	0.10	0.09	-0.17	-0.21	-0.01	1.00	0.10	0.22	-0.20	-0.15	0.06	0.11	-0.18	0.06	**-0.40**	**-0.33**	0.08	-0.11	0.08	**-0.35**
share of equity active in business	-0.15	-0.24	-0.21	0.11	0.01	-0.19	**0.50**	0.14	-0.10	0.02	0.10	1.00	-0.64	-0.03	0.13	0.04	-0.09	0.06	-0.13	**-0.32**	-0.13	0.14	-0.19	**-0.30**	**-0.30**
Other firms' equity share	0.25	**0.35**	**0.33**	0.10	0.08	0.29	**-0.39**	-0.18	-0.22	-0.05	0.22	**-0.64**	1.00	-0.23	-0.18	-0.01	**0.31**	-0.17	0.15	-0.20	-0.21	-0.10	-0.07	**0.47**	0.11
public debt per total debt	-0.10	-0.13	-0.30	**-0.38**	-0.14	-0.13	-0.14	**0.36**	0.08	-0.07	-0.20	-0.03	-0.23	1.00	-0.25	**-0.32**	-0.11	0.11	-0.06	0.18	0.20	0.09	0.08	-0.22	0.03
debt share of domestic private financial institutions	-0.04	-0.04	-0.02	0.12	-0.09	-0.06	-0.15	-0.15	0.19	-0.24	-0.15	0.13	-0.18	-0.25	1.00	-0.17	0.14	0.02	-0.06	-0.08	0.08	0.18	-0.16	-0.07	0.13
debt share of trade credit	0.09	0.04	**0.36**	0.16	**0.36**	0.14	0.24	-0.05	-0.15	0.23	0.06	0.04	-0.01	**-0.32**	-0.17	1.00	0.08	0.00	0.22	0.01	0.02	-0.23	-0.04	0.03	-0.13
exports per turnover	-0.01	0.03	0.14	0.21	0.03	0.13	-0.16	-0.05	-0.06	-0.06	0.11	-0.09	**0.31**	-0.11	0.14	0.08	1.00	-0.12	0.12	-0.15	-0.15	0.10	-0.07	0.17	0.00
Anticipated annual growth rate of turnover	-0.11	-0.15	-0.23	-0.03	-0.04	-0.12	-0.03	**0.36**	0.11	0.04	-0.18	0.06	-0.17	0.11	0.02	0.00	-0.12	1.00	-0.03	0.22	0.15	0.11	0.20	-0.25	-0.05
Manager's business experience in years	0.22	0.25	0.19	0.04	-0.01	0.14	-0.17	-0.05	0.03	0.04	0.06	-0.13	0.15	-0.06	-0.06	0.22	0.12	-0.03	1.00	-0.19	0.01	0.00	-0.07	0.27	**0.32**
Public venture capitalists' equity share	-0.08	-0.12	-0.16	-0.22	-0.14	-0.08	-0.02	0.06	0.13	0.13	**-0.40**	**-0.32**	-0.20	0.18	-0.08	0.01	-0.15	0.22	-0.19	1.00	**0.27**	0.03	**0.29**	-0.21	-0.01
equity share of private venture capitalist	-0.06	-0.09	-0.18	**-0.37**	-0.10	-0.08	0.01	0.16	-0.04	0.00	**-0.33**	-0.13	-0.21	0.20	0.08	0.02	-0.15	0.15	0.01	0.27	1.00	-0.09	-0.08	-0.14	0.22
private capital loans per eq+cl	-0.06	-0.09	-0.10	0.06	0.07	-0.07	0.05	0.17	0.15	-0.19	0.08	0.14	-0.10	0.09	0.18	-0.23	0.10	0.11	0.00	0.03	-0.09	1.00	-0.07	-0.17	-0.06
public capital loans per eq+cl	-0.11	-0.16	**-0.32**	-0.02	-0.05	-0.11	-0.08	0.25	0.25	0.09	-0.11	-0.19	-0.07	0.08	-0.16	-0.04	-0.07	0.20	-0.07	**0.29**	-0.08	-0.07	1.00	-0.23	-0.10
age of firm	**0.57**	**0.70**	**0.35**	0.11	-0.08	0.19	-0.27	-0.30	-0.23	0.02	0.08	**-0.30**	**0.47**	-0.22	-0.07	0.03	0.17	-0.25	0.27	-0.21	-0.14	-0.17	-0.23	1.00	0.11
share of public r&d support used in university research	0.17	0.26	-0.09	-0.10	0.14	-0.01	-0.24	-0.04	0.23	0.02	**-0.35**	**-0.30**	0.11	0.03	0.13	-0.13	0.00	-0.05	**0.32**	-0.01	0.22	-0.06	-0.10	0.11	1.00

Correlation is significant at the 0.01 level (2-tailed).

Correlation is significant at the 0.05 level (2-tailed).

Appendix 3. Results on biotech data compression.[18]

Communalities[a]

	Initial	Extraction
biotech turnover in meuros	1.000	.778
personnel	1.000	.539
total turnover per labor	1.000	.855
profitability (profits per turnover)	1.000	.691
innovation intensity (patent applications per r&d labor)	1.000	.758
commercialization ability (turnover per (1+patent applications+patents))	1.000	.657
post-graduated labor per total labor	1.000	.666
r&d costs per total costs	1.000	.627
public r&d support per r&d costs	1.000	.639
Solidity (equity+caploans per equity+debt)	1.000	.621
principal owner share of equity	1.000	.677
share of equity active in business	1.000	.902
Other firms' equity share	1.000	.788
public debt per total debt	1.000	.714
debt share of domestic private financial institutions	1.000	.854
debt share of trade credit	1.000	.758
exports per turnover	1.000	.546
Anticipated annual growth rate of turnover	1.000	.704
Manager's business experience in years	1.000	.779
Public venture capitalists' equity share	1.000	.747
equity share of private venture capitalist	1.000	.756
private capital loans per eq+cl	1.000	.805
public capital loans per eq+cl	1.000	.739
share of public r&d support used in university research	1.000	.799
age of firm	1.000	.628

Extraction Method: Principal Component Analysis.

a. Only cases for which SME biotech firm = 1 are used in the analysis phase.

[18] The concept of post-graduate personnel stands for research trained people with licenciate or doctoral degree.

Appendix 3. continues.

Total Variance Explained[a]

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	4.409	17.635	17.635	4.409	17.635	17.635	2.641	10.565	10.565
2	2.721	10.883	28.518	2.721	10.883	28.518	2.569	10.277	20.841
3	2.215	8.861	37.379	2.215	8.861	37.379	2.106	8.423	29.265
4	1.881	7.524	44.903	1.881	7.524	44.903	2.073	8.293	37.558
5	1.797	7.188	52.091	1.797	7.188	52.091	1.938	7.752	45.310
6	1.544	6.174	58.265	1.544	6.174	58.265	1.883	7.532	52.842
7	1.262	5.049	63.314	1.262	5.049	63.314	1.806	7.225	60.066
8	1.116	4.464	67.777	1.116	4.464	67.777	1.648	6.590	66.656
9	1.084	4.336	72.113	1.084	4.336	72.113	1.364	5.457	72.113
10	.979	3.915	76.028						
11	.926	3.703	79.731						
12	.814	3.256	82.987						
13	.809	3.238	86.225						
14	.603	2.412	88.637						
15	.520	2.082	90.719						
16	.430	1.721	92.439						
17	.350	1.398	93.838						
18	.316	1.266	95.104						
19	.303	1.214	96.317						
20	.251	1.005	97.323						
21	.214	.858	98.180						
22	.154	.615	98.796						
23	.123	.491	99.287						
24	.110	.440	99.727						
25	6.833E-02	.273	100.000						

Extraction Method: Principal Component Analysis.

a. Only cases for which SME biotech firm = 1 are used in the analysis phase.

Appendix 3. continues.

Component Matrix[a,b]

	Component								
	1	2	3	4	5	6	7	8	9
total turnover per labor	.821	-1.87E-02	-.207	.178	.195	-.104	.189	-6.12E-02	.136
biotech turnover in meuros	.783	.251	-8.65E-03	.241	5.382E-02	-.134	.118	-6.72E-02	-5.98E-02
Other firms' equity share	.639	.398	-.179	-6.12E-02	-.293	-3.17E-03	-7.03E-02	.136	-.277
commercialization ability (turnover per (1+patent applications+patents))	.568	5.381E-02	-.287	-.370	.216	-.135	.139	5.111E-02	.158
age of firm	.554	2.465E-03	.373	-.222	6.283E-02	6.218E-02	-.275	7.393E-02	.210
r&d costs per total costs	-.523	.140	5.261E-02	.429	-.177	5.831E-03	-.188	.284	3.709E-04
principal owner share of equity	.508	-.372	-9.43E-02	.261	-.408	-.108	-1.10E-02	2.096E-02	-.154
exports per turnover	.505	-1.54E-02	.328	-.141	8.274E-02	.247	-2.79E-02	.110	.289
public debt per total debt	-.468	.361	-5.78E-02	1.078E-02	-.279	-.464	3.983E-02	5.759E-05	.256
share of equity active in business	-.259	-.764	.399	.199	3.910E-02	-1.20E-03	-5.76E-02	-5.00E-02	.211
post-graduated labor per total labor	-.218	-.639	-1.98E-02	.194	.342	-.132	-.176	-6.90E-02	3.801E-02
share of public r&d support used in university research	3.994E-02	.615	.483	.250	.125	.108	-.107	-.282	6.986E-02
personnel	.292	.436	.382	-9.64E-02	-2.19E-02	-8.88E-02	-.245	.184	-8.58E-02
debt share of domestic private financial institutions	-8.29E-02	-4.42E-02	.593	-.377	.229	.272	.320	-.139	-.321
Public venture capitalists' equity share	-.248	.288	-.537	-.198	.441	4.302E-02	.239	-4.74E-02	.139
innovation intensity (patent applications per r&d labor)	.341	-1.84E-03	4.606E-03	.577	-9.41E-02	2.949E-03	-4.20E-02	-.393	-.380
debt share of trade credit	.340	-.261	-.205	.408	.528	.165	-8.44E-02	.210	-9.07E-02
equity share of private venture capitalist	-.324	.157	.314	2.529E-04	.523	-.331	.109	.118	-.346
Solidity (equity+caploans per equity+debt)	-3.96E-02	.280	-.329	.365	.428	.229	-6.32E-02	-.175	.171
profitability (profits per turnover)	.366	-.345	5.412E-02	-.119	-.209	.587	.170	1.104E-02	5.749E-02
public capital loans per eq+cl	-.307	.172	-.419	2.455E-02	-.183	.541	-.279	.184	-1.47E-02
private capital loans per eq+cl	-4.06E-02	-3.37E-03	.119	.335	-.331	-6.90E-02	.696	-5.30E-02	.274
Anticipated annual growth rate of turnover	-.349	.143	-8.39E-04	.182	1.516E-02	.350	.433	.383	-.268
Manager's business experience in years	.190	.240	.387	.433	.151	-1.12E-02	5.713E-02	.494	.278
public r&d support per r&d costs	-.286	.405	.160	.135	-2.48E-02	.370	-5.80E-02	-.418	.186

Extraction Method: Principal Component Analysis.

a. 9 components extracted.

b. Only cases for which SME biotech firm = 1 are used in the analysis phase.

Appendix 3. continues.

Rotated Component Matrix[a,b]

	Component								
	1	2	3	4	5	6	7	8	9
r&d costs per total costs	-.673	-.119	-.297	-1.53E-02	-1.38E-02	.200	9.059E-02	-.151	3.932E-02
commercialization ability (turnover per (1+patent applications+patents))	.633	.307	.124	-.124	.205	2.345E-02	-.287	-6.32E-02	-4.55E-02
total turnover per labor	.626	.190	.193	.400	.292	.236	-.213	-.159	.135
Anticipated annual growth rate of turnover	-.604	.153	.136	-9.16E-02	.221	6.637E-02	-.115	.354	.313
public capital loans per eq+cl	-.580	.203	.231	-.200	.258	-.171	9.172E-02	-.337	-.224
age of firm	.445	7.242E-02	.291	-2.52E-02	-.249	.428	8.671E-02	-4.11E-02	-.291
share of equity active in business	-7.52E-02	-.883	.157	1.830E-02	-.270	7.994E-02	-5.22E-02	2.082E-02	8.930E-02
Other firms' equity share	.162	.754	.117	.313	-9.81E-02	.109	-.145	-.154	-.126
post-graduated labor per total labor	2.676E-03	-.748	-5.74E-02	9.715E-02	.122	-7.80E-02	-.217	7.902E-03	-.161
profitability (profits per turnover)	6.042E-02	1.076E-03	.809	3.993E-02	-.101	-2.83E-02	-5.41E-02	-6.37E-02	.118
public debt per total debt	-.152	9.627E-02	-.651	-.298	-.149	-5.69E-02	.157	-.216	.270
exports per turnover	.361	5.445E-02	.446	-7.53E-02	-9.50E-02	.432	9.635E-02	-3.92E-03	-5.57E-02
innovation intensity (patent applications per r&d labor)	3.521E-03	3.457E-02	1.955E-02	.853	3.766E-02	-5.39E-02	.152	-2.21E-02	3.425E-02
principal owner share of equity	.117	1.957E-02	.223	.543	-.282	8.420E-03	-.360	-.311	.111
biotech turnover in meuros	.470	.399	6.396E-02	.519	.114	.316	-3.99E-02	-4.54E-02	9.010E-02
Solidity (equity+caploans per equity+debt)	-3.73E-02	-1.74E-02	-5.58E-02	.111	.705	5.504E-02	.291	-.127	-5.19E-02
Public venture capitalists' equity share	7.193E-02	.154	-.180	-.386	.674	-.273	-2.44E-03	6.559E-02	5.424E-02
debt share of trade credit	5.045E-02	-.219	.220	.365	.545	.296	-.315	2.089E-02	-.203
Manager's business experience in years	-8.93E-02	1.969E-02	-4.09E-02	3.927E-02	8.321E-02	.853	2.364E-02	2.375E-02	.180
personnel	.103	.387	-9.42E-02	3.066E-02	-.253	.440	.161	.126	-.265
public r&d support per r&d costs	-.184	3.003E-02	2.930E-02	-5.58E-02	.127	-6.58E-02	.758	-1.57E-02	6.471E-02
share of public r&d support used in university research	1.857E-02	.185	-.151	.169	1.990E-02	.362	.738	.192	-2.38E-02
debt share of domestic private financial institutions	5.752E-02	-5.00E-02	.306	-.133	-.218	-6.09E-02	.206	.802	1.006E-02
equity share of private venture capitalist	-8.05E-02	-.119	-.474	-4.17E-02	.104	.145	-4.44E-02	.680	-.115
private capital loans per eq+cl	-3.07E-02	-3.28E-02	6.537E-03	7.767E-02	-7.35E-02	7.612E-02	6.021E-02	-3.61E-02	.884

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

a. Rotation converged in 22 iterations.

b. Only cases for which SME biotech firm = 1 are used in the analysis phase.

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