ETLA
ELINKEINOELÄMÄN TUTKIMUSLAITOS
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
Lönnrotinkatu 4 B 00120 Helsinki Finland Tel. 358-9-609 900
Telefax 358-9-601 753 World Wide Web: http://www.etla.fi/

Keskusteluaiheita – Discussion papers

No. 926

Antti-Jussi Tahvanainen* – Raine Hermans**

FINANCIAL PECKING ORDER AND THE VALUE PLATFORM OF INTELLECTUAL CAPITAL

Observing the Finnish Biotechnology Industry

* The Research Institute of the Finnish Economy (ETLA) and Etlatieto Ltd, Lönnrotinkatu 4 B, FIN-00120 Helsinki
E-mail: antti.tahvanainen@etla.fi
** The Research Institute of the Finnish Economy (ETLA) and Etlatieto Ltd, Lönnrotinkatu 4 B, FIN-00120 Helsinki
E-mail: raine.hermans@etla.fi

ISSN 0781-6847 25.08.2004

TAHVANAINEN, Antti-Jussi – HERMANS, Raine, **FINANCIAL PECKING ORDER AND THE VALUE PLATFORM OF INTELLECTUAL CAPITAL**. **Observing the Finnish Biotechnology Industry**. Helsinki: ETLA, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 2004, 34 p. (Keskusteluaiheita, Discussion Papers, ISSN 0781-6847; no. 926).

ABSTRACT: This study analyzes the question how the intellectual capital (IC) of a company affects its financial capital structure. To this end we consecutively apply the methods of factor and regression analyses on a sample of 65 small and medium sized Finnish biotechnology companies. Based on the results we find that firms with a well-balanced IC base finance their operations to a larger extent with retained earnings and debt while companies with less well-balanced IC bases revert to other sources of financing, for example, capital loans and external equity. Utilizing Myers' (1984) pecking order theory as a theoretical backdrop we are able to show potential rationales behind deviating capital structure choices made by companies with dissimilar IC bases.

1 Introduction

1.1 Background

Conforming to the laws of the market mechanism, a company's ability to raise financing is directly linked to its value as perceived by investors. For the assessment of companies' market values, in turn, investors usually consider key indicators like, for example, present market shares, product portfolios, business expertise, turnover figures, and profitability indices, as well as future forecasts thereof. Based on the indicators it is possible to compute net present values (NPV), pay-off periods, and other indicators that describe the productivity of investments. These indicators serve as the basis for investment decisions.

However, the valuation of companies in knowledge-intensive industries, like biotechnology, can be executed only with high risks based upon such indicators. Companies in knowledge-intensive industries are frequently unable to provide reliable indicators and show certain distinguishing characteristics that make it difficult to assess their value. In Finland, they cannot even be assessed relying on their historical development due to the infant nature of the entire industry. In these industries the book value on the balance sheet conveys only limited information on the true value of companies as the capitalization of R&D expenditures on the balance sheet is optional and thus, two otherwise identical firms may appear different if just the balance sheet information is consulted. Even more importantly, intellectual capital (IC), the most critical engine of value creation according to the knowledge management literature, is not captured in the balance sheet at all (Lev 2001, Edvinsson and Malone 1997 and Sveiby 1997).

In 2002, many Finnish biotechnology companies were still in an infant stage of commercialization. Over 40 percent of companies founded after 1991 showed negative profits and approximately 60 percent showed a personnel count of 10 or less. Only 49 percent employed a full-time marketing expert (Hermans and Luukkonen 2002). On the other hand the share of employees with a scientific education was high. 60 percent of firms employed personnel that also held a university position. Moreover, with high R&D intensities[1], that in some cases exceeded 75 percent, the business risk is pronounced making a reliable assessment

[1] R&D expenditure / total costs

of company value even more difficult as the probability of success in this early stage of operations is still relatively uncertain. This translates into difficulty obtaining financing as observed by Hermans and Luukkonen (2002), concerning especially companies with a history rooted in academia (Tahvanainen 2004).

Nevertheless, returns in case of success can more than offset the risks. In global markets revenues created by pharmaceutical products, for example, are massive. The question is how to evaluate these knowledge-intensive businesses without conventional indicators. One answer has been proposed by the knowledge management literature, whereby the intellectual capital base of a company is the primary source of value and the generator of future sales (Sveiby 1997, Edvinsson and Malone 1997), and thus might serve as a base for value assessment. The hypothesis is suitable for knowledge-intensive industries since it measures intangible assets that should already be in place even in young and small companies that have not necessarily entered the markets yet. Supportive of the theory, Hermans and Kauranen (2003) are able to estimate 70 percent of the anticipated future sales of Finnish biotechnology SMEs based on their respective intellectual capital bases.

Assuming that the intellectual capital base is a good proxy for the ability to generate value and provide investors with information necessary to make reasonable investment decisions, it should implicitly have an effect on the ability of a company to obtain financing. Prior to this study, Catasús and Gröjer (2003) have examined this effect on the availability of debt financing. We expand the examination to comprise the whole capital structure including retained earnings, capital loans and external equity. We also contribute to the discussion by applying conventional capital structure theory to justify capital structure choices made actively by sample firms.

1.2 Aims and methods

This study analyzes the questions whether and how the intellectual capital (IC) of a company affects its financial capital structure and its use of distinctive sources of financing. To this end, we apply a two-staged approach on a sample of 65 small and medium sized Finnish biotechnology companies.

In the first stage, the intellectual capital of companies is measured leaning on the value platform model introduced by Edvinsson and Malone (1997). The presence of different IC configurations in companies is captured by feeding IC indicators into a factor analysis. The analysis uses the indicators to form factors and factor scores representative of the IC configurations in the sample companies. In the second stage of the analysis, the IC factor scores obtained in stage one serve as independent variables in a linear regression analysis that estimates the capital structure ratios of sample companies that are constructed based on the capital structure literature, especially Myers' (1984) financial pecking order theory.

The paper proceeds as follows. In Section 2 we elaborate on the theoretical background, namely theories on intellectual capital and the pecking order theory. In Section 3 we give the underlying data. The two-staged analysis is presented in Section 4. Section 5 gives the results. Section 6 follows discussing the findings and Section 7 concludes the paper.

2 Theoretical background

2.1 Capital structure literature

The capital structure literature is rather broad, encompassing numerous theories on the rationale behind capital structure choices. In this study, we utilize only Myers and Majluf (1984) and Myers (1984). Comprehensive reviews on the literature as a whole are presented by Harris and Raviv (1991), as well as Klein, O´Brien and Peters (2002).

Myers and Majluf (1984) argue that the information asymmetry between insiders of a company and potential investors results in some cases in a decrease of equity value when equity is issued and a rejection of positive NPV investments in others. The chain of argumentation leading to these hypotheses goes as follows.

For simplicity, firms are divided into high value (H) and low value (L) companies. In our case type H firms are endued with a well-balanced IC base, whereas type L firms display an IC base lacking at least one of the three IC components. Reality is not as simple, of course, but if the terms "high" and "low" describe the relative values of companies under comparison, not absolute values, this simplified setting can be transferred to describe any two firms. For investors it is not possible to determine whether the firm they are about to invest in is type H or L since asset value and revenue streams, in our case also intangible assets, are assumed to be unobservable before the equity issue. Thus, we have the case of information asymmetry addressed above. For the argumentation to hold, Myers and Majluf (1984) assume that the management maximizes the value of existing shareholders and that investors are rational.

Consider a project that needs outside financing. The outside financing comes in the form of an equity issue and finances 100 percent of the project. In the moment of the issue, investors cannot observe whether the issuing firm is type H or L due to the information asymmetry. All they know is that if they valued the equity of the issuing company according to the true value of an H type firm and the firm turned out to be type L after the issue, current stakeholders of the L type would gain supernormal pay-offs and new investors would pay too much for their claims due to the overpricing. It is not in the interest of the managers of an L type firm to identify themselves as such, because they maximize the wealth of their current shareholders. Pretending to be type H just might work out and the equity is overpriced earning the current shareholders supernormal wealth gains in the amount of the overpriced margin. Anticipating this behavior and being unable to verify the true value of the firm, investors accordingly adjust the price offer for the equity downwards. The result for the L type firm is that its equity is priced fairly. Current shareholders let go of a fraction of their claims equal to the fraction of the investment of total firm value including the added NPV of the project and gain the net present value of the project.

For an H type firm the situation looks worse. Since the firm cannot credibly verify its true type, the equity to be issued is under priced by the investors. If the resulting wealth loss incurred to the current shareholders of the firm does not exceed the value created by the investment (i.e. the NPV of the project), then the project will still be accepted if and only if the project cannot be financed by any other means. But if undercutting the real equity price is severe enough, that is the difference of the true value of the H type firm and the value predicted by the investors is sufficiently large, the loss incurred is greater than the value created by the project and current shareholders experience a net wealth decrease. In this case the project will be rejected although it has a positive net present value and no equity is issued.

The argumentation implies that, in equilibrium, type H firms never issue equity, and if they do, only as a last resort. L type firms, on the other hand, are always eager to issue equity since they have nothing to loose. Thus, the issue of equity is a signal that the firm is type L. In case of an equity issue announcement, investors therefore tend to lower their assumption of the firm value, no matter what type the firm is, leading to a fall in the value of existing shares.

Myers (1984) names the implications of the argumentation the “pecking order theory”. He argues that investments of a firm are financed according to the following pecking order. First, a firm in need of financing draws on internal sources. Since the information asymmetry does not appear among insiders, there is no wealth destroying aspect to it. Company shares will not be downgraded. Also, internal financing does not involve any issue costs and is therefore preferred to any kind of outside financing, even if terms would otherwise resemble those of internal funding. Second, only if internally generated cash flows are insufficient to fund all positive NPV projects do managers consider issuing securities of any kind. This can happen, for example, if in times of fluctuating cash flows a sticky dividend policy inhibits the flexible use of cash (i.e. canceling dividend payments and redirecting funds to investments) or cash is simply not generated, as in the case of many biotechnology companies. In such cases, firms always issue debt before equity, because its value is independent of asymmetric information. The single debt security is a fixed claim worth the same no matter whether the firm is type L or H [2]. Thus, debt is priced fairly and is cheaper than equity. Outside equity is at the bottom of the pecking ordersince its issue incurs the depreciation of firm value on top of the usual issue costs, which are already more expensive for equity than debt.

Myers’ (1984) theory has implications on the study at hand. If Hussi (2004) is right and intangible assets are indeed not taken into account by investors, as argued below, the information asymmetry concerning firm value between the companies and financial markets persists, and we should obtain empirical evidence from the data that is in line with the pecking order theory.

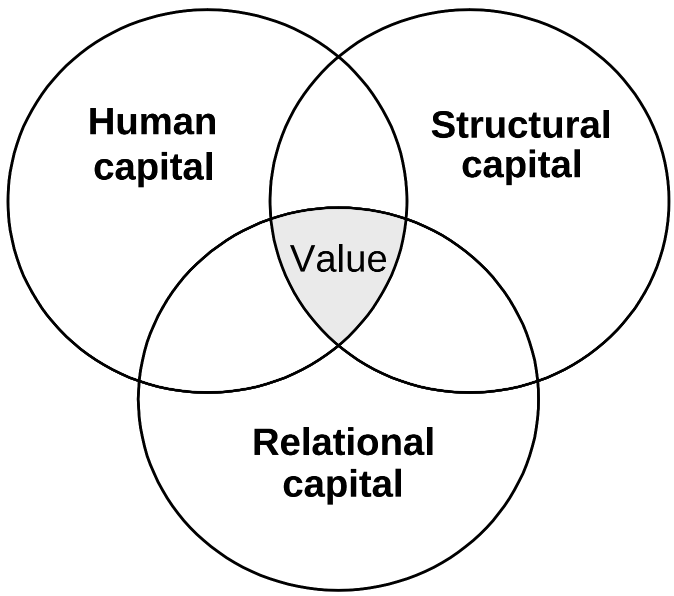
2.2 Knowledge management literature

We base the measurement of intellectual capital in the sample companies on the value platform model initially introduced in Edvinsson and Malone (1997). The model is presented graphically in Figure 2.1. The names for the three components of IC, namely human, structural, and relational capital, have been modified to match the definitions proposed by the MERITUM project (2002) (see also Sveiby 1997 and Edvinsson and Malone 1997). Sveiby

[2] Assuming that the target of investment and the related risk is known to investors. Otherwise a hold-up problem between shareholders and debt holders arises increasing the price of debt. This matter is discussed in detail by Jensen and Meckling (1976).

(1997) designates the components “individual competence”, “internal structures”, and “external structures” respectively. Edvinsson and Malone (1997), in turn, talk about “customer capital instead of external structures disregarding thereby relationships to all other stakeholders like suppliers, competitors, academia, and so forth that are critical for advancing research towards the market place as successful R&D-activities often are conducted within networks of co-operation (see, e.g. Hermans and Luukkonen 2002 or Nilsson 2001).

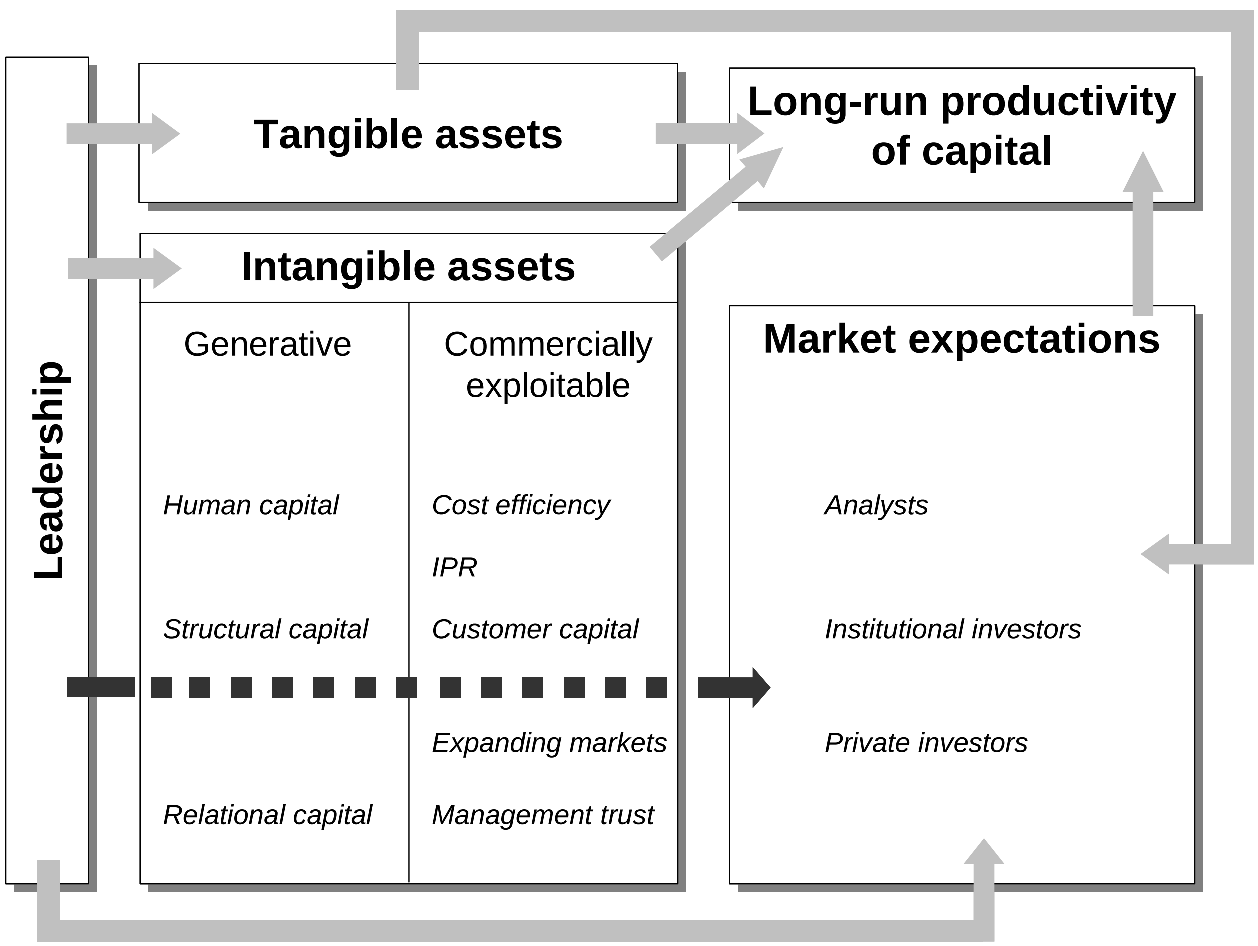
Figure 2.1 Value platform model



According to the value platform model, value is created in a company when all three components of IC, the generative intangible assets (Hussi 2004), are managed in a way that they support each other. This is the very purpose of knowledge management. While human capital encompasses the knowledge, experiences, skills, and competencies of the personnel, structural capital comprises physical and conceptual structures present in the company that facilitate the support, enhancement, protection, intra-firm distribution, and documentation of human capital residing in the company. Relational capital can be understood as a network of virtual and physical relationships and connections among the critical stakeholders of a company. Through this network the company is able to leverage intra-organizational achievements, be it products, intellectual property rights, services, results of research, communication, or people to the periphery of the company. According to the model, all three components are critical success factors in the sense that in the absence of any single component only modest value can be created. The aim of the above-mentioned factor analysis will be to identify and separate companies enduing all three components of IC from companies with incomplete IC bases.

According to Hussi (2004) the interaction of the generative intangible assets creates value by turning knowledge into commercially exploitable intangible assets. Such assets can be, for example, cost efficient production processes, intellectual property rights, functioning customer relations, expanding markets, and so forth. These are assets that a company can immediately benefit from financially. Figure 2.2 shows the comprehensive framework that clarifies the role of intangible assets, comprising both generative and commercially exploitable intangible assets, in the generation of long-run productivity of capital. Since we are not primarily interested in the whole picture but rather in the factors based on which the financial markets evaluate potential target companies, we have modified Hussi's (2004) model to include a pointer depicting this aspect (black arrow). Otherwise Figure 2.2 matches the original in Hussi (2004).

Figure 2.2 Factors of long-run productivity of capital modified from Hussi (2004).



Revisiting Hussi's (2004) framework shortly, there are three factors that affect the long-run productivity of capital employed in a company. These are intangible assets, tangible assets, and the expectations of the market. All three factors are influenced and coordinated by appropriate leadership on the part of the company.

What the framework fails to address is the direct interaction between intangible assets and market expectations, more specifically the financial markets. It assumes that investors do not take intangible assets into account when evaluating a company. As Hussi (2004) states, "in reality, the financial markets turn out to base their estimates on relatively limited information, as they tend to use mainly information on leadership, management, and tangible assets and even in the best cases scant information on intangible assets." Thus, Hussi (2004) does not interconnect intangible assets with market expectations.

In the present study we challenge this view. We claim that intangible assets are measurable using existing "knowledge management metrics" as reviewed by, for example, Liebowitz and Suen (2000). Pioneering empirical application of such metrics has been performed by Hermans and Kauranen (2003), Hermans and Kulvik (2004), and Hermans (2004). Another claim is that investors use these metrics in the evaluation process of a company. Additionally we propose that, instead of directly evaluating the leadership of a company, investors also use the metrics to assess the quality of leadership indirectly as it is expresses endogenously in the IC base of a company. This is intuitive, since good leadership aims at a well-balanced IC base. In the case of knowledge-intensive industries the intangible asset based valuation of companies would be especially well-founded, since in these industries intangible assets are of far greater value than any other type of asset. Thus, disregarding intangible assets would render the valuation of a knowledge-intensive company futile.

In order to be able to test our claims we need a pecking order framework that deals explicitly with the kind of information asymmetry that arises between the firm and the financial markets due to the alleged unwillingness of investors to regard intangible assets. Companies with a well-balanced IC base should shun external financing, especially external equity, and utilize internally generated cash flows more heavily than other types of firms. It should be pointed out that the pecking order theory claims that the capital structure of a particular firm is determined by the firm itself choosing the most inexpensive source of finance at a given point in time. It does not address situations in which financing is rationed by the financial market and certain financing sources are simply not available. Leaning on in-depth experience from the Finnish biotechnology sector, we take this matter into consideration when discussing the results in the concluding part of the study.

3 Sample and data

The analysis at hand is based on cross-sectional private survey data comprising 64 small and medium sized Finnish biotechnology companies (biotechnology SMEs) at the end of 2001. SMEs in this paper are defined according to official definitions of the EU excluding firms that employ more than 250 people and match at least one of the following criteria: (i) Annual turnover > 40 mill. EUR, (ii) balance sheet total > 27 mill. EUR. Data concerning balance sheet items has been supplemented and checked with data from the National Board of Patents and Registration of Finland (PRH). The original survey encompasses 84 biotechnology companies, the majority of the 120 companies that were operational in 2001 in the Finnish biotechnology sector. Out of these 84 companies 72 are small and medium sized. The final sample of 64 companies used here is somewhat smaller due to missing values in some individual cases.

The companies in the sample are independent businesses, partnerships, or subsidiaries of bigger corporations. In the two latter cases the businesses must be an independently responsible business unit in order to be included in the sample. If the criteria are not fulfilled, the data is collected from the parent company. No companies 25 years or older met the criteria for inclusion. It should be pointed out that the majority of firms excluded for their large size belonged to this age category and the remaining “old” firms could not be included due to the lack of coherent data. Therefore, the final sample consists of SMEs that are younger than 25 years. There are no severe outliers in terms of data on equity, capital loans, or debt.

The data contains information on company backgrounds, the start-up phase of companies, products, markets, and customers, as well as R&D activities and financing. The information on financial aspects includes the affirmed financial statements of 2001.

4 Methods and selection of variables

The empirical part of this study consists of a two-stage analysis that aims at relating intellectual capital residing within a firm to its capital structure.

In the first stage, we apply a factor analysis that serves three purposes. Firstly, it identifies different configurations of interaction between the variables representing the three components of IC by breaking down the data into non-correlated factors with each of them representing a certain configuration. We are especially interested in configurations that display interaction between all three components of intellectual capital, but also need configurations of only two or just a single component in the second stage of the analysis as benchmarks. Secondly, by using the factor analysis technique in the first stage we avoid potential problems in the second stage of the analysis that might be evoked by correlation among the variables used, since the outputted factors are not correlated. Finally, we need the factors and the factor scores thereof as input for the second stage of the analysis.

In the second stage, we use a linear regression model to estimate whether and how the capital structures of companies with differing IC-configurations deviate from one another. According to their respective IC-configuration, companies receive factor scores in the first stage of the analysis that are then used to estimate their capital structure in the second stage. Based on the results of the second stage we can draw implications on the relationship between IC and the pecking order hypotheses of Myers (1984).

4.1 Factor analysis and independent variables

As already stated above the purpose of the factor analysis is to form factors that represent different configurations of IC components. Loosely speaking, the generalized least squares (GLS) factor analysis identifies correlating variables from the set of inputted IC indicators and groups them together as factors that are not correlated with each other. In the present study we use the VARIMAX rotation method to ensure that the resulting factors are clearly distinguished from one another for higher informational quality. As a result we obtained five factors, each representing a certain configuration of IC. They are presented in Table A2 in the Appendix.

Concerning the construction and choice of variables that measure the quality and quantity of individual IC categories, we lean on the concept of intangible assets displayed in Figure 2.2 above. Therein intangible assets are subdivided into generative intangible assets and commercially exploitable intangible assets. The separate examination of generative intangible assets and commercially exploitable intangible assets allows us to determine the individual effects that the two categories have on the capital structure of a company.

4.1.1 Commercially exploitable intangible assets (CEIA)

We use three variables for the approximation of commercially exploitable intangible assets. Instead of measuring exploitable intangible assets directly, we measure the outcomes of successfully commercialized intangible assets. The first variable is a straightforward turnover indicator measuring the turnover of sample companies in euros per year. It can be argued that turnover quantifies the level to which intangible assets are actually exploited. The second variable measuring commercially exploitable intangible assets is a dummy indicating whether companies have brought an innovation to market in the past three periods. The third indicator is a ratio indicating turnover per employee that measures the companies' efficiency in creating returns as related to labor input. Descriptive statistics for all three variables are presented in Table 4.1.

Table 4.1 Descriptive statistics for variables measuring CEIA

Variable	N	Min	Max	Mean	Std. Deviation
Turnover (ln)	69	0.00	18.90	11.04	4.596
Innovation on markets	72	0.00	1.00	0.65	0.479
Turnover per employee (mill. euro)	69	0.00	5.38	0.13	0.650

4.1.2 Generative intangible assets

For the identification of variables that approximate generative intangible assets appropriately, we rely mainly on the discourses of Sveiby (1997). According to Sveiby the variables can be broken down into three separate variable classes with each representing a different aspect of generative intangible assets and business as a whole. These classes can be named according to the aspects they are representing, namely, (i) growth and renewal, (ii) efficiency, and (iii) stability.

It can be argued that variables from all three classes are included in the analysis. Nevertheless, it should be pointed out that the class measuring aspects of stability, in particular, is underrepresented. This is because many companies in the sample are still rather young and in the pre-market phase of operations, where stability aspects are not of a central concern. The utmost priority of these companies is to invest heavily in R&D that, in time, will result in a commercially exploitable product or service that will recoup prior investments. R&D investments are very risky in nature and incompatible with the notion of stability by definition. On the other hand and for the very same reason, the variable class representing aspects of growth and renewal is strongly represented.

In the following we present all variables that are included in the factor analysis. In accordance with the value platform model of intellectual capital, we have divided the generative intangible assets and the variables approximating them into the three components, namely, human, structural, and relational capital. Each component is treated separately. In conjunction with the presentation of variables in each category, we also briefly discuss which of the variable classes (growth & renewal, efficiency, stability) the particular variables belong to.

HUMAN CAPITAL (HC)

Four distinct variables are chosen to approximate human capital. These variables comprise (i) the total number of personnel, (ii) the share of personnel holding a doctoral degree, (iii) the experience of the chief executive officer measured in years, and (iv) a dummy indicating whether the companies are endued with full-time in-house marketing expertise. Hermans and Kulvik (2004) use similar variables for the purposes of measuring human capital.

As knowledge in its natural, uncodified, and tacit form resides within individuals we utilize the total number of personnel to capture and quantify the total mass of knowledge inherent in the companies. As the biotechnology industry is knowledge-intensive in character and depends on human capital as the engine of innovation, we assume that a critical mass of complementary and cohesive human capital is essential for super-normal performance, or taken to the extremes, for survival. In order to avoid problems that result from a skewed distribution of the variable, we transform the variable into the logarithmic form with the natural base.

The share of personnel holding a doctoral degree is obtained by simply dividing the number of personnel with a doctor's degree by the total number of personnel. As opposed to the latter variable that measured the quantity of human capital, this indicator expresses its quality. We assume that through the educational training and the related practical experience, doctors possess the ability to apply knowledge in a more structured and efficient way. Additionally we assume that doctors have thereby assimilated more knowledge than personnel without a doctoral degree.

In contrast to the two latter indicators, which measure human capital related to scientific knowledge, the two remaining indicators quantify knowledge that is related to organizing and managing a company as a business. The CEO's business experience is measured in logarithmically transformed years. The variable indicating the existence of marketing expertise in-house is a dummy variable and quantifies roughly the knowledge required for the promotion of products and services on markets.

Table 4.2 Descriptive statistics for variables measuring human capital (HC)

Variable	N	Min	Max	Mean	Std. Deviation
Number of personnel (ln)	72	0.00	4.91	2.31	1.159
Share of doctors of total personnel	72	0.00	1.00	0.30	0.308
CEO's business experience (in years)	71	0.00	3.71	2.23	0.729
In-house marketing expertise	72	0.00	1.00	0.43	0.499

While the number of employees over time directly expresses the growth of a company and can therefore be argued to belong to the variable class of "growth and renewal", at least the latter two variables can be classified to indicate stability.

STRUCTURAL CAPITAL (SC)

The structural capital of a company includes activities, schemes, policies, and programs, as well as systems, regulations, guides, rights, and facilities that support, enhance, protect, distribute, and document the human capital residing in that company. In more concrete terms this includes the organization of activities like R&D, the protection of R&D investments with immaterial property rights, company policies on diverse aspects like secrecy and competing activities, information systems and guidelines concerning the standards of conduct in the laboratory, as well as bonus and educational programs.

In the IC literature one encounters numerous alternatives for measuring structural capital. According to the ICM Group study (1998) SC can be proxied by, for example, administrative expenses, computers per employee, corporate quality performance, and investments in IT. Roos *et al*. (1998) suggest measures like training expenses per employee, renewal expenses, and new patents filed. Sveiby (1997) lays emphasis on information technology inputs. In this study we utilize four different indicators to proxy structural capital that are more in line with Deeds' (2001) notion stressing the importance of research and development related activities for the maximization of a company's innovation potential and, thus, its value creation ability.

The indicators used here are (i) R&D-costs per employee, (ii) number of patents per employee, (iii) the share of patent applications of the sum of applications and existing patents, as well as (iv) the age of the company. As opposed to Sveiby's (1997) more static IT oriented variables that can be argued to belong to the class "stability", the included variables clearly represent the variable class "growth and renewal" and express the companies' ways of organizing their research and development activities that aim at maximizing their respective innovation potential.

The variable indicating R&D costs per employee is obtained by dividing the number of personnel by total research and development costs. It expresses the intensity with which a company aspires to transform the human capital residing in its personnel into commercially exploitable assets by providing incentives, facilities, equipment, and other resources that translate into R&D costs. This variable belongs to the class "growth and renewal".

In this study, the number of patents per employee is a measure of structural capital. It is not conceived to be a measure of commercially exploitable intangible assets as in, for example, Ahonen (2001). Surely, Ahonen's argumentation, that patents *per se* can be sold or licensed and generate revenues thereby, holds and speaks in favor of his categorization of the variable. Nevertheless, it should be pointed out that the number of patents conveys no information on the quality of these and, thereby, on the extent to which they actually are commercially exploitable. In other words, the sheer presence of patents does not imply their importance to the companies' value creation. In this study we interpret patents as a structural device for the codification of tacit knowledge, that is human capital, and the investments therein. From this perspective it is justifiable to see patents as structural capital. Another argument in favor of this interpretation relates to the fact that patents are the tangible output of human capital that is owned by the company as opposed to human capital itself that is the property of each individual employee. By patenting the company secures its proprietary rights to the products of human capital that could otherwise spillover outside the company with any employee leaving the organization.

The variable indicating the share of patent applications of the sum of applications and existing patents describes the state and nature of the company. A company that displays very few new applications in comparison to its existing patent portfolio is more established and static in nature and exploits already existing assets. It has its roots in the past. A company with a high share of patent applications, on the other hand, is more dynamic, strives to renew itself and expects to create value in future. This variables belongs to the class “growth and renewal”.

The age of a company expresses the stability of operations and the ability to create value steadily. It also proxies the amount of learning that has taken place within the company and become a part of the company structure. Usually, such learning is eminent in, for example, established unwritten codes of conduct that have proven to be efficient. Since such codes and ways of doing things are not codified in the data, we revert to age as an approximation.

Table 4.3 Descriptive statistics for variables measuring structural capital (SC)

Variable	N	Min	Max	Mean	Std. Deviation
R&D costs per employee	72	0.00	1.40	0.07	0.186
Number of patents per employee	72	0.00	21.43	0.81	2.665
Patent applications / (applications + patents)	71	0.00	0.92	0.31	0.297
Age (ln)	72	0.00	3.18	1.92	0.650

RELATIONAL CAPITAL (RC)

Relational capital, in contemporary literature, also often referred to as customer capital (Edvinsson and Malone 1997 and Stewart 1997), can be measured in many ways. Indicators of relational capital include, according to the ICM Group study (1998), market share and customer satisfaction indicators, customer specific sales figures, and numbers of new customers, as well as markets. These indicators express a company's relationship to its customers, the most focal interest group in terms of revenue creation. Sveiby (1997) extends this customer oriented approach on relational capital to also encompass the relationship of the company to its suppliers. In this study we further extend variables to also capture relations to academia. For the process of value creation, bi-lateral access to synergetic and complementary research on a co-operative basis is a critical success factor for biotechnology companies as product development can be accelerated and modified in line with advancements in basic research. Close contact with academia also secures direct access to human capital within academia that can be directly utilized through co-operative arrangements, out-sourcing, or recruitment.

Since many of the biotechnology companies do not yet have customers, indicators like those suggested by the ICM Group (1998) above are not sensible from the perspective of validity. Nevertheless, we use a variable that depicts the companies' relationship to markets abroad, as the real potential for value creation resides not within domestic boundaries but on global markets. The variables used to proxy the relational capital of companies include (i) the share of exports of total turnover, (ii) the share of public R&D support used for university research, and (iii) a dummy variable indicating whether the companies' co-operate with a foreign university.

Table 4.4 Descriptive statistics for variables measuring relational capital (RC)

Variable	N	Min	Max	Mean	Std. Deviation
Exports per turnover	71	0.00	1.00	0.37	0.411
Share of public support used for university research	69	0.00	1.00	0.23	0.305
Firm collaborates with a foreign university	69	0.00	1.00	0.13	0.650

An additional dummy variable is inserted into the factor analysis in order to control for effects related to the unique characteristics of the pharmaceutical industry. Features of the pharmaceutical industry include very long product development phases and resource consuming drug approval processes. Thirty-five percent of the sample consists of companies active in the pharmaceutical industry.

Table 4.5 Descriptive statistics for control variable "Pharma"

Variable	N	Min	Max	Mean	Std. Deviation
Pharma (=1)	72	0.00	1.00	0.35	0.479

In the descriptive statistics the number of observations varies depending on the variable throughout Tables 4.1 to 4.5. Our intent is to provide maximum information at this stage. In the process of the factor analysis itself observations with missing values are automatically excluded and N settles at 65 after the exclusion of 7 observations. The results of the factor analysis are reported in more detail together with the results of the following regression analysis in Section 5.

Table A1 (see Appendix) displays the correlation matrix of all variables included in the factor analysis. The matrix facilitates a more elaborate and structured depiction of the underlying data. It also shows that the data is coherent in the sense that it displays patterns that are in line with common sense expectations.

For example, firms that employ experienced CEOs can be positively related to relatively large and old companies. They also correlate positively with relatively large revenue streams and co-operative links to academia in R&D. Furthermore, they have in-house marketing expertise. Firms that employ a relatively high share of doctors, on the other hand, are negatively related to firm size and in-house marketing expertise. These firms also less often have an existing product or service on the markets. Also pharmaceutical companies can be associated with features that are rather plausible, namely, with relatively high R&D and labor intensities, high patent creativity, and collaborative arrangements with universities. They also have less often succeeded in bringing products or services to the market place.

4.2 Regression analysis and dependent variables

The purpose of the regression analysis is to test whether different IC configurations of companies affect their respective capital structure. Four different financial ratios are estimated using the factor scores[3] obtained in stage one of the analysis as independent variables. Instead of estimating a simple debt-to-equity ratio we scrutinize partial ratios for two reasons. First, testing Myers' (1984) pecking order hypotheses requires a more detailed analysis of the debt-to-equity ratio including the separate identification of the share of internal equity, external equity, and debt of a firm's total financing. Second, as already concluded in Tahvanainen (2003) and Hermans (2004), the controversial features and a central role of capital loan financing in Finnish biotechnology necessitate its explicit and separate treatment. The estimated ratios include (i) the earnings, (ii) the external equity, (iii) the capital loan, and (iv) the debt ratio.

Table 4.6 Descriptive statistics for dependent variables

Variable	N	Min	Max	Mean	Std. Deviation
Earnings ratio	67	-11.38	0.98	-0.82	1.917
External equity ratio	69	0.00	1.00	0.56	0.383
Capital loan ratio	69	-2.46	5.04	0.51	0.986
Debt ratio	69	0.00	1.09	0.37	0.339
Tangible assets ratio	69	0.00	0.75	0.14	0.164

The ratios are calculated as follows. The earnings ratio measures the degree to which operations are financed internally:

$$\text{(1)} \qquad \text{Earnings ratio} = \frac{\text{Retained earnings}}{\text{Total equity} + \text{total liabilities}} ,$$

where total equity includes capital loans in accordance with Finnish accounting legislation, and total liabilities are corrected for accounts payable, as well as accrued charges and deferred credits. The correction of liabilities is performed because the above-mentioned balance sheet items do not express financing decisions that have been made explicitly and strategically, but are the sheer result of the size, volume, and life cycle effects of the business.

[3] For each of the five factors obtained in the first stage of the analysis, every observation receives a factor score, the value of which depends on how well the particular factor represents the particular observation.

External equity is the share of adjusted total equity owned by individuals or organizations not being actively involved in the daily business of the company of which they are shareholders.

(2) $$\text{External equity ratio} = \frac{\text{External equity}}{\text{Adjusted total equity}},$$

where adjusted total equity is computed from total equity by subtracting capital loans and retained earnings from it. Additionally to retained earnings, we exclude capital loans from total equity prior to any ratio computations to avoid potential distortions caused by the controversial features of capital loans that, although legally treated as equity, show many characteristics of debt financing. Retained earnings are an internal source of equity. Thereby, the definition of adjusted total equity in this study matches that of equity in the pecking order literature as closely as possible.

Capital loan ratio is calculated as follows:

(3) $$\text{Capital loan ratio} = \frac{\text{Capital loans}}{\text{Adjusted total equity} + \text{total liabilities} + \text{capital loans}},$$

where the definitions of elements comply with those already treated above. It should be pointed out that retained earnings are left out of the equation intentionally, because a number of companies display negative earnings so large that their unadjusted total equity (without capital loans) is negative. Computing a ratio thereof does not provide results with interpretative value. As stated by Tahvanainen (2003), capital loans as a source of financing deserve and require a separate examination due to its hybrid nature combining features of equity and debt. The treatment of capital loans as an integral part of equity might result in distortions that render the results of the analysis worthless.

Debt ratio is denoted as:

(4) $$\text{Debt ratio} = \frac{\text{Total liabilities}}{\text{Adjusted total equity} + \text{total liabilities} + \text{capital loans}},$$

where definitions of elements comply with those already treated above. Again, the problematic effects of retained earnings are corrected for by excluding them from the computation.

As already discussed, the factors of analysis stage one represent generative intangible assets. According to the framework presented in Figure 2.2 investors infer the value of a company by taking its tangible assets into account. Therefore, we include a separate variable indicating the share of tangible assets of the balance sheet total into the regression.

In order to estimate the effects of different IC configurations and tangible assets on the above ratios the independent variables are inserted into a linear regression model using the OLS method. The model is run separately for all four ratios. The formal expression of the model takes the following form:

(5) $$D_i = \alpha + \beta I_i + \delta C_i + \varepsilon_i \,,$$

where D represents the dependent variable, here the various capital ratios. The constant is represented by the term α in the formula. The independent variables, here the factor scores, are incorporated into the model by the vector I. The regression coefficient of the vector I is denoted as β. C is the control vector representing control dummies and other control. The term δ is the coefficient of the vector C. The error term is marked by ε and the subscript index i serves as the firm index.

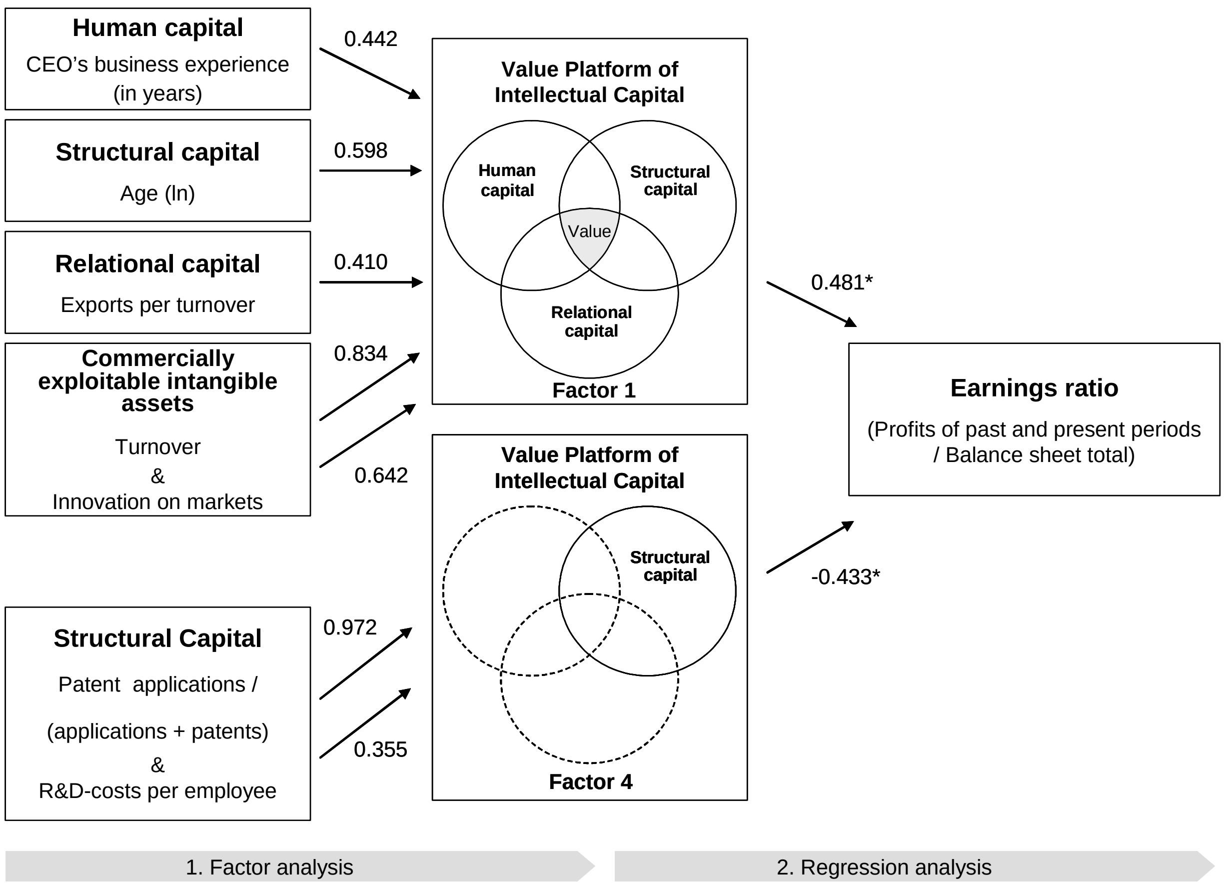
5 Results

Figures 5.1 to 5.4 display the combined results of the factor and regression analyses. They present the statistically significant variables that particular factors consist of and the relationship of these factors to the capital structure ratios introduced above. Separate and comprehensive results for both analyses are provided in Tables A2 and A7 in the Appendix.

5.1 Earnings ratio

Figure 5.1 shows the factors that interact with the earnings ratio. Two out of five factors explained the variation in the ratio significantly, namely factors 1 and 4. Factor 1 represents firms with a well-balanced IC base. All three IC components are present with the CEO's experience embodying human capital, the age of firms representing structural capital, the export ratio standing for relational capital and turnover, as well as the product-on-markets indicator representing commercially exploitable intangible assets. At this point one should point out that factor 1, the only factor representing a well-balanced IC base, is the sole factor comprising commercially exploitable intangible assets.

Figure 5.1 Factors interacting with the earnings ratio



Firms that are represented by factor 1 display a higher earnings ratio. The coefficient of the regression analysis is positive and statistically significant at the 10 percent level.

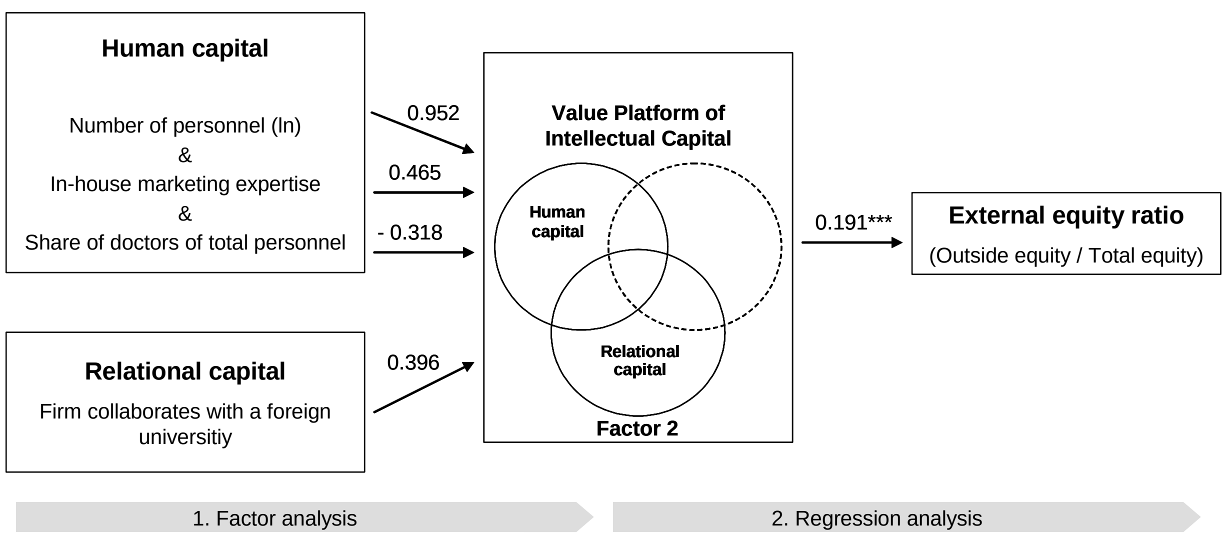
Factor 4 represents firms with an incomplete IC base having only structural capital. In factor 4 structural capital is expressed by the variables indicating the ratio of patent applications of the total patent portfolio and the R&D intensity. Firms represented by factor 4 show a negative relationship to the earnings ratio. The coefficient is significant at the 10 percent level.

In other words, these findings indicate that the most research intensive and innovative firms have been unable to generate significant cash flows.

5.2 *Outside equity ratio*

Figure 5.2 shows the results for the external equity ratio. Factor 2 is the only factor explaining the ratio. It represents an incomplete IC base having only human and relational capital. In factor 2, human capital is expressed by the number of personnel, in-house marketing experience, and the share of doctors of total personnel, where the share of doctors is in a negative relationship to the other variables. Relational capital is expressed by the variables indicating collaboration between a firm and a foreign university. Firms represented by factor 2 have a higher outside equity ratio. The coefficient is significant at the one percent level.

Figure 5.2 Factors interacting with the outside equity ratio



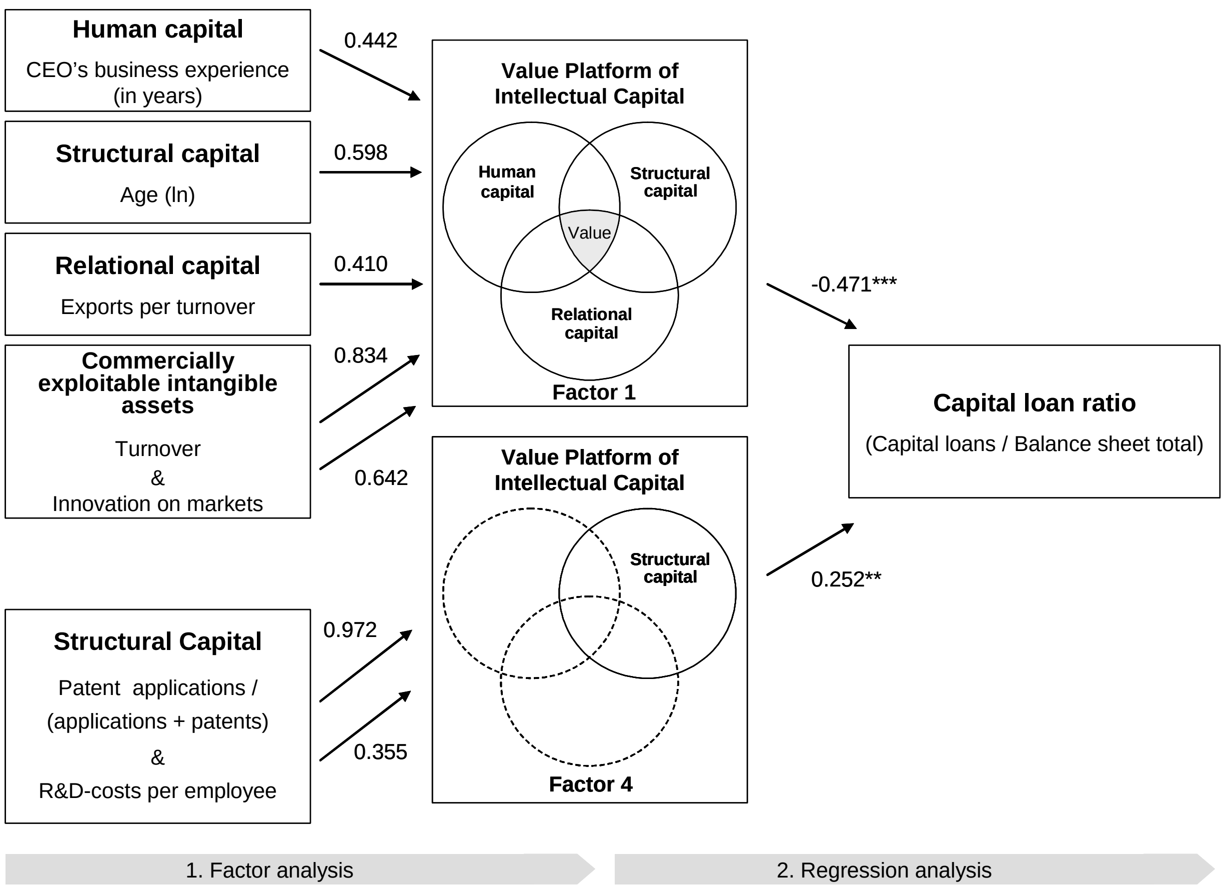
The results for factor 2 can also be interpreted inversely negating all coefficient fore signs. Then factor 2 would represent firms with few personnel, no marketing experience, a high share of doctors, and no collaborative arrangements with foreign universities. Firms represented by this inverse factor 2 have a lower external equity ratio.

One can also argue that those firms, which have obtained financing in terms of external equity, have been able to increase their size. Or, investors have steered these firms to recruit people with marketing competencies. Such problems of reverse causality or simultaneity bias will be further discussed below.

5.3 *Capital loan ratio*

Figure 5.3 presents the results for the capital loan ratio. Again, factors 1 and 4 affect the ratio. Firms with a well-balanced IC base represented by factor 1 are negatively correlated to the capital loan ratio, whereas firms represented by factor 4 have a higher capital loan ratio. The coefficient of factor 1 is significant at the one percent level and the coefficient of factor 4 at the five percent level.

Figure 5.3 Factors interacting with the capital loan ratio

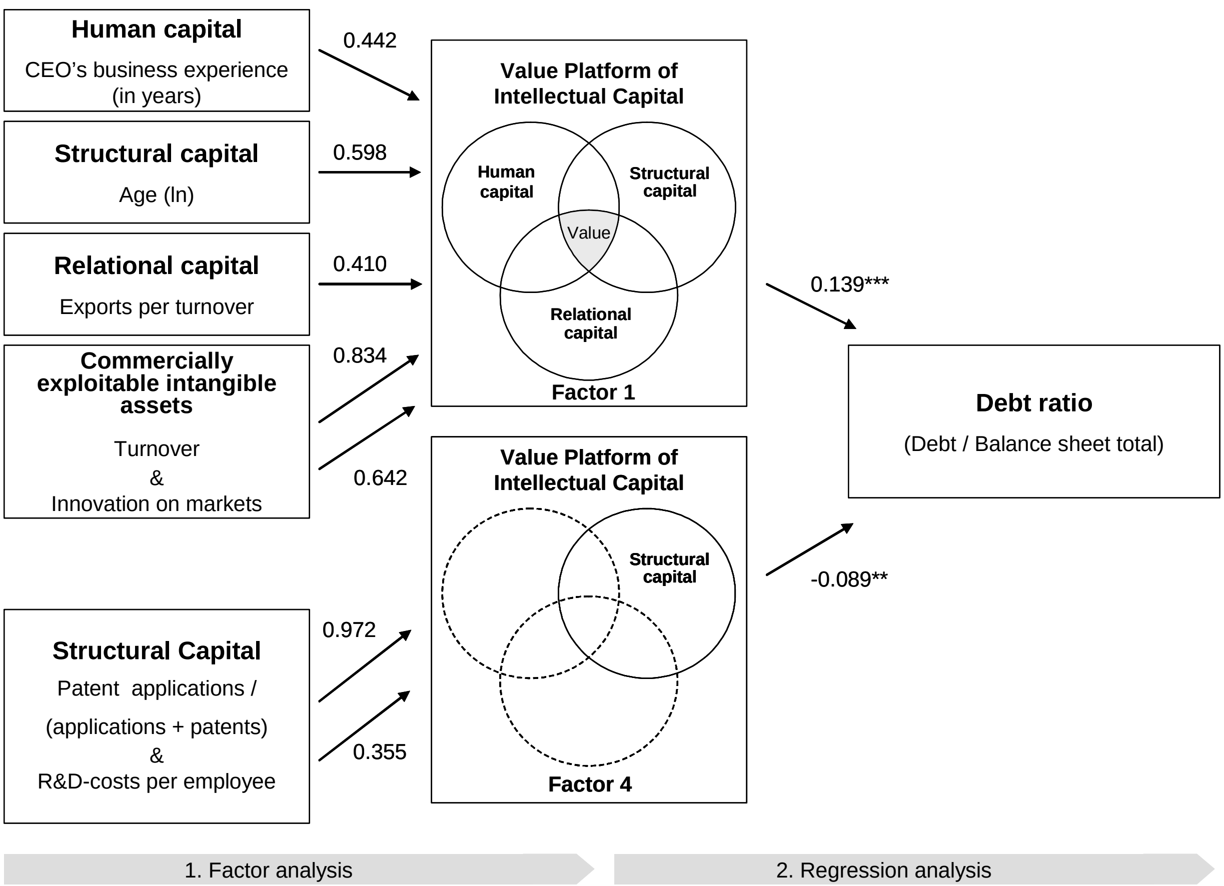


Young and research intensive firms, which have an inexperienced CEO and which have not generated sales or exports, do have relatively high capital loan injections. This stresses the significant role of the Finnish government in the financing of the infant industry given that the government has provided more than half of the industry's capital loans (Hermans and Tahvanainen 2002, Tahvanainen 2003, Hermans 2004).

5.4 Debt ratio

Figure 5.4 shows results for the debt ratio. Factors 1 and 4 are the sole factors with explanatory power. Well-balanced firms show a positive affiliation to the debt ratio with a coefficient being significant at the one percent level. Firms represented by factor four are negatively correlated to the ratio. The coefficient for factor 4 is negatively significant at the five percent level.

Figure 5.4 Factors interacting with the debt ratio



When the firm is mature and has already generated sales, it can obtain debt financing. If the firm's only collaterals are based on structural capital, here the research activities, it seems difficult to acquire any debt.

6 Discussion

Based on the empirical evidence, we find that the results are in line with Myers' (1984) pecking order framework. Firms that are of high value according to the IC framework and display a well-balanced IC base (factor 1) shun external equity financing and revert to retained earnings and debt financing relatively more than other types of firms. According to the perspective of the pecking order hypothesis, this behavior aims at avoiding the undervaluation of equity. Also in line with the hypothesis, firms of allegedly lower value (factor 2) utilize relatively more external equity financing as their equity is not as severely undervalued. Firms with only a single IC component, here structural capital related to research intensity and innovativeness (factor 4), prefer capital loans as a source of financing relatively more than other firms. Capital loans are a special feature of the Finnish financial markets and play a decisive role in the financing of the biotechnology industry. Thus, they deserve separate treatment.

Assuming that the pecking order hypotheses indeed is the driving force behind the findings, this implies that the information asymmetry between the sample firms and financial markets truly exists, and that a strong IC base does not positively affect the availability of financing. If the IC base of companies was observable and it revealed the true value of a company by nullifying the information asymmetry, we would be unable to evidence a pecking order like behavior, as the companies' equity is always priced fairly on markets making firms indifferent between financing sources.

The findings render our claims false concerning the active use of knowledge management metrics. Either (a) intangible assets are unobservable or (b) investors simply do not bother to apply information beyond leadership, management, and tangible assets when evaluating companies, as Hussi (2004) states. As comprehensive knowledge management metrics do exist, the former notion is hardly defendable. Thus, the latter is the more believable explanation and constitutes a challenge for those aiming to promote knowledge management beyond the boundaries of scientific discussion and towards its application in the field.

6.1 Issues of reverse causality

In the underlying study we lean on cross-sectional data. This confronts us with a reverse causality problem. We cannot definitely show whether a company's capital structure is determined by its IC base or whether financing comes with constraints that force a company to adapt its IC base accordingly. Thus, the validity of the discussion above rests very much on the validity of the pecking order hypothesis. The theory implies that the decisions from which source and to what extent financing is to be drawn are made actively by the companies that, for their part, optimize the cost of financing. This view supports the notion that a company's IC base explains its capital structure as interpreted above.

Nevertheless, blindly taking the theory's perspective as given might oversimplify reality.
It is assumable that biotechnology firms, in their infant stage, are not in the position to choose from different sources of financing freely to such an extent as knowledge intensive operations require. In fact, in the start-up phase companies are usually happy to receive any financing, regardless of the terms with which it comes. As soon as the founding capital is consumed, these companies usually turn to venture capitalists in the hope of getting financed, as the debt market is still out of reach due to a lack of lacking collateral and revenue streams. In this situation the pecking order is reversed (see Hyytinen and Pajarinen 2002).

The stage in the life cycle of a firm might not have an effect only on the validity of the pecking order theory, but also on the direction of causality between the IC base and the capital structure of a company. Knowing that investors, especially venture capitalists, apply harsh direct regulation on the companies in which they invest, receiving financing from external sources will most probably have an effect on company structures and thereby also on the IC base of companies. Young companies that are dependent on investments can be argued to be affected especially, as guidelines for the development of operations is dictated by investors. It can be argued that in the early stages of the life cycle the IC base of a company is determined to a large extent by financial markets and not the reverse.

Assuming that investors are rational, they develop the target company's IC base towards a more balanced configuration according to the principles of knowledge management. Once companies mature under the guidelines of investors and grow more independent, firms finally start behaving according to the pecking order, as the strengthening IC base is monitored to an ever decreasing level by outsiders and terms for external equity turn ever more unfavorable. This loosening of control over the development of the IC base by investors can be defended by two separate arguments. First, after a company reaches a certain stage in its life cycle and business success seems more certain, investors actively seek to exit the venture in order to cash in their investment. Thus, they let go of the control over the company. Second, one might argue that the development of the IC base has a momentum of its own beyond the conscious control of investors. If investors monitor the development only in the scope of their own guidelines then a part of the IC base will be unobserved. Thus, an information asymmetry between the firm and investors arises. At this stage of the life cycle the causality between the IC base and the capital structure might be reversed again with the IC base dominating the capital structure.

6.2 An alternative interpretation

With this more dynamic framework in mind we can interpret the results in a new light. Factors 1, 2, and 4 can be interpreted to represent firms in different stages of the life cycle. The question remains whether these firms make static financing decisions according to the principles of the pecking order in their particular stages of the life cycle. Starting with factor 4, firms represented by that factor are probably at a very early stage of their life cycle. They are highly R&D intensive building a robust IPR portfolio that aims at securing future operations. Value can be expected to be created in the distant future making investments at this stage very risky. Debt financing is not available due to a lack of revenue and collaterals and operations are still at such an infant stage that external equity investments are regarded as too risky and investment periods too long by investors. This leaves factor 4 companies with a financing gap. However, this gap is closed by capital loans, a financing instrument designed to support young technology start-ups to overcome the early phases of operations. Our analysis shows that the instrument is working and utilized by the right target group as intended. Over 50 percent of capital loans are provided by the National Technology Agency of Finland, Tekes, making it a key component in the national innovation system as far as the biotechnology industry is concerned (see also Hermans and Tahvanainen 2002, Tahvanainen 2003).

Factor 2 companies are already more established showing human capital and relational capital in their IC base. They have in-house marketing expertise at their disposal, which is very much appreciated by investors. Also the network to outside research institutions is initiated. Such a company represents a good example of what a growing but still immature company could look like under the guidance of professional investors. External equity has been injected into the company, which explains the relatively high external equity ratio. At the same time investors demand the reinforcement of the IC base. At this stage the information asymmetry between the firm and the financial markets is still relatively small.

Factor 1 companies are the most mature ones and can be placed further up in the life cycle than companies represented by any other factor. They are able to generate internal income, value, already and are thus more independent in terms of financing. With a well-balanced IC base these firms are of highest value according to the knowledge management literature, and are as such prone to suffer from the undervaluation of equity relatively more than other types of firms. As shown by the empirical evidence, factor 1 firms act accordingly, preferring retained earnings and debt financing over external equity.

7 Conclusions

In this study we set out to answer the question whether the intellectual capital base of a company affects its capital structure. To this end we utilized a 2002 cross section of 65 small and medium sized Finnish biotechnology companies. In the first stage, we resorted to a factor analysis as a method to categorize companies according to their intellectual capital configurations providing every observation with a factor score for each generated factor. Then in a second stage, the factor scores were used to estimate a number of capital structure ratios derived from the capital structure literature.

We were able to show for the first time that companies with differing intellectual capital bases indeed also exhibit differing capital structures. While companies with well-balanced intellectual capital bases have relatively high retained earnings and debt ratios, companies endued with only structural capital display relatively high capital loan ratios. Companies, the IC bases of which consist of human and relational capital only, show relatively high external equity ratios. In a static framework one can argue that the findings are in line with the financial pecking order hypothesis of Myers (1984), implying that, despite existing knowledge management metrics deliberately created for the measurement of IC, an information asymmetry concerning the IC of companies still persists between sample firms and financial markets.

Due to the lack of time series data we were unable to control for a possible reverse causality of results. The dynamic development of the IC base and the capital structure of a company could well be induced by either or both with the direction of effect shifting in the course of a company's life-cycle. The unveiling of a dynamic interaction between intellectual capital and capital structures constitutes an attractive area for further research that has a large potential to contribute decisively to the understanding of corporate financial behavior from the perspective of knowledge management. Injecting new interdisciplinary ideas for approaching the matter seems welcome, since the related discussion has followed rather rigid trajectories for the past two decades building incremental additions to existing frameworks (For a comprehensive review of capital structure theories and their development over time see, e.g., Harris and Raviv 1991). We point out the necessity of using time series data if such research is conducted.

As a policy implication we suggest that IC metrics should be applied in investment decisions. IC metrics could be compared between an individual firm and the entire industry. It seems that IC metrics could stand as a basis for the evaluation of the most promising investment decisions and also as a basis for the strategically meaningful development of companies following these investment decisions.

References

Catasús, B. - Gröjer, J.-E. (2003): "Intangibles and credit decisions: results from an experiment". *European Accounting Review*, Jul2003, Vol. 12, No. 2, pp. 327-355.

Edvinsson, L. - Malone, M. S. (1997): "Intellectual capital – The proven way to establish your company's real value by measuring its hidden brainpower. Judy Piatkus, London.

Harris, M. - Raviv, A. (1991): "The theory of capital structure". Journal of Finance, MAR, VOL. 46, no. 1, p. 297-355.

Hermans, R. (2004): "International mega-trends and growth prospects of the Finnish biotechnology industry – Essays on new economic geography, market structure of the pharmaceutical industry, sources of financing, intellectual capital and industry projections". Dissertation for the Department of Industrial Engineering and Management, Helsinki University of Technology. A 40 series, 172 pages, The Research Institute of the Finnish Economy, Helsinki.

Hermans, R. - Kauranen, I. (2003): "Intellectual capital and anticipated future sales in small and medium-sized biotechnology companies." Discussion paper 856, 30 pages. The Research Institute of the Finnish Economy, Helsinki. Available at http://www.etla.fi.

Hermans, R. – Kulvik, M. (2004): "Measuring Intellectual Capital and Sources of Equity Financing – Value Platform Perspective within the Finnish Bio-Pharmaceutical Industry. Forthcoming in International Journal of Learning and Intellectual Capital.

Hermans, R. - Luukkonen, T. (2002): "Findings of the ETLA survey on Finnish biotechnology firms". Discussion paper 819, 35 pages. The Research Institute of the Finnish Economy, Helsinki.

Hussi, T. (2004): "Reconfiguring Knowledge Management. Combining Intellectual Capital, Intangible Assets and Knowledge Creation". *Journal of Knowledge Management* Vol. 8(2), pp. 36-52.

ICM Group, Inc. (1998): "What are companies currently measuring?". http://www.icmgroup.com/presentpub/LES_MEASUREMENT.

Liebowitz, J. – Suen, C. Y. (2000): "Developing knowledge management metrics for measuring intellectual capital". *Journal of Intellectual Capital*, VOL. 1, No. 1, pp. 54-67.

MERITUM Project (2002): "Guidelines for managing and reporting on intangibles (Intellectual Capital Report). Fundación Airtel Móvil, Madrid.

Myers, S. C. - Majluf, N. S. (1984): "Corporate financing and investment decisions when firms have information that investors do not have". *Journal of Financial Economics,* JUN, VOL. 13, no. 2, pp. 187-221.

Myers, S. C. (1984): "The Capital Structure Puzzle". *Journal of Finance*, JUL, VOL. 39, no. 3, pp. 575-592.

Nilsson, A.S. (2001): "Interaction between researchers, firm managers and venture capitalists – The essence of biotechnology business". Centre for Medical Innovations, Karolinska Institutet, Stockholm.

Roos, J. - Roos, G. - Dragonetti, N. - Edvinsson, L. (1998): *"Intellectual Capital: Navigating in the New Business Landscape"*. New York University Press, New York, NY.

Sveiby, K. E. (1997): *"The new organizational wealth: Managing and measuring knowledge based assets"*. 220 pages, Berrett-Koehler Publishers, Inc., San Francisco.

Tahvanainen, A.-J. (2004): "Academic spin-offs in Finnish biotechnology – A portrait of firm characteristics". Discussion paper 900, 34 pages. The Research Institute of the Finnish Economy, Helsinki.

Appendix

Table A1 Correlation matrix

Variable code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1														
2	-.341**	1													
3	-.072	.298 *	1												
4	-.318 **	.500 ***	.309 **	1											
5	.134	.123	.137	.173	1										
6	.055	-.149	.085	.031	-.028	1									
7	-.092	.153	.419 ***	.083	.036	.105	1								
8	-.173	.230	.079	.273 *	.369 **	-.051	-.184	1							
9	-.091	.232	.099	.006	.142	.018	.352 **	.075	1						
10	-.192	.263 *	.300 *	.318 **	.000	.351 **	.144	.082	.051	1					
11	-.102	.346 **	.090	.212	.125	.108	-.045	.235 *	-.046	.360 **	1				
12	-.291 *	.050	.190	.104	-.089	.094	.238 *	-.133	.162	-.105	-.134	1			
13	.189	.244 *	-.051	-.045	.276 *	.176	-.106	.202	-.087	.139	.199	-.326 **	1		
14	-.117	.154	.165	.151	-.041	-.026	.107	-.152	-.079	-.073	-.088	.107	-.094	1	
15	-.168	.306 *	.282 *	.088	-.076	-.010	.417 ***	-.159	.349 **	-.189	-.115	.534 ***	-.187	.263 *	1

*** Correlation is significant at the 0.001 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Variable code legend:

1 Doctors / personnel, 2 lnpersonnel, 3 Ceo's experience in years (ln), 4 full-time marketing expertize, 5 RD / personnel, 6 Patents / total personnel, 7 Age (ln), 8 patent applications / (patent applications + patents), 9 Exports / turnover, 10 Share of public support used for university research, 11 Collaboration with foreign university, 12 Innovation to markets within past 3 years, 13 Pharma=1, 14 Sales / Personnel, 15 Liikevaihto€ (ln)

Table A2 Rotated factor matrix

Variable	Factor				
	1	2	3	4	5
lnliikevaihto€	.834				
Innovation 2 markets within past 3 years	.642				
lnagent	.598				
lnceoexp	.442				
exports per turnover	.410				
SalesPerPersonnel					
lnpersonnel		.952			
full-time marketing expertize		.465			
Collaboration with foreign university		.396			
post-graduated labor per total labor		-.317			
share of public r&d support used in university research			.887		
Patents / total personnel			.522		
patent applications / (patent applications + patents)				.972	
RDPerPersonnel				.355	
Pharma=1					.969

Extraction Method: Generalized Least Squares. Rotation Method: Varimax with Kaiser Normalization.

Table A3 Communalities for the factor analysis

Variable	Initial	Extraction
post-graduated labor per total labor	.367	.457
lnpersonnel	.595	.999
lnceoexp	.347	.460
full-time marketing expertize	.396	.453
RDPerPersonnel	.291	.382
Patents / total personnel	.340	.417
lnagent	.407	.523
patent applications / (patent applications + patents)	.352	.999
exports per turnover	.335	.478
share of public r&d support used in university research	.476	.861
Collaboration with foreign university	.308	.368
Innovation 2 markets within past 3 years	.452	.586
Pharma=1	.432	.999
SalesPerPersonnel	.181	.259
lnliikevaihto€	.563	.779

Extraction Method: Generalized Least Squares.

Table A4 Total variance explained (factor analysis)

Factor	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	2.939	19.590	19.590	1.930	12.867	12.867	2.063	13.754	13.754
2	2.413	16.084	35.674	1.035	6.902	19.769	1.646	10.973	24.727
3	1.507	10.045	45.719	1.711	11.409	31.178	1.397	9.314	34.041
4	1.417	9.445	55.164	1.375	9.165	40.343	1.238	8.252	42.293
5	1.139	7.591	62.755	1.526	10.174	50.517	1.234	8.224	50.517
6	1.000	6.665	69.419						
7	.820	5.464	74.883						
8	.705	4.698	79.581						
9	.686	4.572	84.153						
10	.593	3.950	88.103						
11	.521	3.473	91.575						
12	.447	2.979	94.555						
13	.334	2.224	96.778						
14	.271	1.805	98.583						
15	.213	1.417	100.000						

Extraction Method: Generalized Least Squares.

Table A5 KMO and Bartlett’s test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.576
Bartlett's Test of Sphericity	Approx. Chi-Square	233.488
	df	105
	Sig.	.000

The KMO measure of sampling adequacy does not quite meet the limit of .600, which is conventionally held as a critical value. However, Bartlett’s test of sphericity shows that a factor analysis can be applied on the data at a 0.1 percentage risk level.

Table A6 Goodness-of-fit test

Chi-Square	df	Sig.
28.255	40	.918

The goodness-of-fit test implies that the factor solution is able to explain the variance of initial variables.

Table A7 Results for the regression analysis

Dependent variable:	**Earnings ratio**	**External equity ratio**	**Capital loan ratio**	**Debt ratio**
R^2	.171	.325	.168	.251
Adjusted R^2	.083	.255	.082	.174
F-test	1.956*	4.645***	4.126*	3.244***
Variable	β	β	β	β
Constant	-.773**	.569***	.242***	.330***
	(.322)	(.055)	(.047)	(.053)
Factor 1:	.481*	.041	-.090**	.139***
HR+SC+RC+CEIA	(.258)	(.045)	(.038)	(.042)
Factor 2:	-.308	.191***	.019	-.002
HC+RC	(.251)	(.043)	(.037)	.041
Factor 3:	-.267	.065	-.037	-.022
SC+RC	(.251)	(.044)	(.037)	(.041)
Factor 4:	-.433*	-.021	.070**	-.089**
SC	(.236)	(.041)	(.034)	(.039)
Factor 5:	.347	.027	.001	.008
Pharmaceuticals	(.239)	(.041)	(.034)	.039
Tangible assets	-.549	.105	-.036	.278
	(1.517)	(.263)	(.221)	.250

Standard errors in parentheseis. Asterisk labels (*) stand for level of statistical risk of rejecting the null hypothesis incorrectly. (*) 10 per cent , (**) 5 per cent , (***) 1 percent risk level.

E L I N K E I N O E L Ä M Ä N T U T K I M U S L A I T O S (ETLA)

THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
LÖNNROTINKATU 4 B, FIN-00120 HELSINKI

Puh./Tel. (09) 609 900 Telefax (09) 601753
Int. 358-9-609 900 Int. 358-9-601 753
http://www.etla.fi

KESKUSTELUAIHEITA - DISCUSSION PAPERS ISSN 0781-6847

Julkaisut ovat saatavissa elektronisessa muodossa internet-osoitteessa:
http://www.etla.fi/finnish/research/publications/searchengine

No 894 RAINE HERMANS, Projected Growth Effects of the Biotechnology Industry – the fourth pillar of the finnish economy?. First version 02.02.2004, Revised version 16.03.2004. 21 p.

No 895 PEKKA TSUPARI – PETRI ROUVINEN, Inter-Firm Collaboration and Electronic Business: Effects on Profitability in Finland. 06.02.2004. 19 p.

No 896 TOMI HUSSI, Intellectual Capital and Maintenance of Work Ability – The Wellbeing Perspective. (Revised version 25.02.2004). 30 p.

No 897 TOMI HUSSI, The Managerial Relevance of Maintenance of Work Ability – A Finnish Perspective. 27.02.2004. 20 p.

No 898 HANNU PIEKKOLA, Active Ageing Policies in Finland. 05.03.2004. 42 p.

No 899 Demographic Aspects of Ageing and Time Use in a Set of European Countries. 05.03.2004. 20 p.

No 900 ANTTI-JUSSI TAHVANAINEN, Academic Spin-offs in Finnish Biotechnology – A Portrait of Firm Characteristics. 15.03.2004. 34 p.

No 901 PETRI ROUVINEN, Diffusion of Digital Telephony – Are Developing Countries Different? 15.03.2004. 17 p.

No 902 MAARIT LINDSTRÖM – OLLI MARTIKAINEN – HANNU HERNESNIEMI, Tietointensiivisten palvelujen rooli metsäklusterissa. 16.03.2004. 49 s.

No 903 MARKKU STENBORG, Are There Biases in the Market Definition Procedure? 16.03.2004. 14 p.

No 904 PEKKA YLÄ-ANTTILA – JYRKI ALI-YRKKÖ – MARTTI NYBERG, Foreign ownership in Finland – boosting firm performance and changing corporate governance. 17.03.2004. 38 p.

No 905 ESSI EEROLA – NIKU MÄÄTTÄNEN, On the Political Economy of Housing's Tax Status. 19.03.2004. 20 p.

No 906 RITA ASPLUND, A Macroeconomic Perspective on Education and Inequality. 23.03.2004. 22 p.

No 907 RITA ASPLUND, The Provision and Effects of Company Training. A brief review of the literature. 08.04.2004. 24 p.

No 908 KEREM TOMAK, Behavioral Economics of Mobility. 16.04.2004. 26 p.

No 909 LIISA LEIJOLA, The Education System in Finland – Development and Equality. 17.05.2004. 24 p.

No 910 ANNI HEIKKILÄ – HANNU PIEKKOLA, Explaining the Desire for Local Bargaining: Evidence from a Finnish Survey of Employers and Employees. 21.05.2004. 20 p.

No 911 HANNU PIEKKOLA, Active Ageing and the European Labour Market: Synthesis Report. 30.04.2004. 58 p.

No 912 DMITRY EFREMOV – DANIL SMIRNYAGIN – OLGA VALERIANOVA – HANNU HERNESNIEMI, Esco Companies in Northwest Russia, Legal Issues and Organizational Schemes. 06.05.2004. 46 p.

No 913 PETRI ROUVINEN – PEKKA YLÄ-ANTTILA, Palveluyrittäjyys kasvaa nopeimmin ja työllistää eniten. 11.05.2004. 34 s.

No 914 KARI E.O. ALHO, The Finnish EMU Buffers and The Labour Market under Asymmetric Shocks. 19.05.2004. 14 p.

No 915 HANNU HERNESNIEMI, Funktionaalisten elintarvikkeiden klusteri, Esiselvitys. 31.05.2004. 36 s.

No 916 CHRISTOPHER PALMBERG – MIKA PAJARINEN, The Global Dispersion of Innovative Activities – The Case of Finnish Multinationals. 09.06.2004. 28 p.

No 918 LAURA PAIJA, Allocation of Control Rights to Customised Products: Empirical Analysis of Finnish SMEs. 10.08.2004. 38 p.

No 919 MIKA MALIRANTA – PETRI ROUVINEN, Informational Mobility and Productivity – Finnish Evidence. (Tiedollisen liikkuvuuden tuottavuusvaikutukset Suomessa). 22.07.2004. 14 p.

No 920 MIKA MALIRANTA – SATU NURMI, Analyzing entrepreneurship with the Finnish linked employer-employee data (FLEED). Matching and qualitative properties of the data. 29.07.2004. 20 p.

No 921 EDVARD JOHANSSON – HANNU AHO – URPO KIISKINEN – KARI POIKOLAINEN, The association of alcohol dependency with employment probability: Evidence from the population survey "Health 2000 in Finland". Alkoholiriippuvuus ja todennäköisyys olla kokopäivätyössä: Tuloksia "Terveys 2000" aineistosta. 02.08.2004. 28 p.

No 922 ANNIKA EVÄLÄ, Koulutuksen panokset ja tuotokset – Suomi kansainvälisessä vertailussa. 24.06.2004. 93 s.

No 923 ARI HYYTINEN – MIKA PAJARINEN, Opacity of Young Firms: Faith or Fact? 06.08.2004. 24 p.

No 924 PAAVO SUNI, Kiina maailmantaloudessa – Globaalitalouden kasvu ja teollisen työnjaon muutos, Taustaraportti (China in The World Economy – Global Economic Growth and the Changing International Division of Labour, A Background Report). 23.08.2004. 24 s.

No 925 VILLE KAITILA, The Factor Intensity of Accession and EU15 Countries' Comparative Advantage in the Internal Market. 25.08.2004. 23 p.

No 926 ANTTI-JUSSI TAHVANAINEN – RAINE HERMANS, Financial Pecking Order and the Value Platform of Intellectual Capital. Observing the Finnish Biotechnology Industry. 25.08.2004. 34 p.

Elinkeinoelämän Tutkimuslaitoksen julkaisemat "Keskusteluaiheet" ovat raportteja alustavista tutkimustuloksista ja väliraportteja tekeillä olevista tutkimuksista. Tässä sarjassa julkaistuja monisteita on mahdollista ostaa Taloustieto Oy:stä kopiointi- ja toimituskuluja vastaavaan hintaan.

Papers in this series are reports on preliminary research results and on studies in progress. They are sold by Taloustieto Oy for a nominal fee covering copying and postage costs.