Supporting Measures for Research & Development as a
Stimulus for Technology Transfer and Academic
Entrepreneurship in Estonia

Indrek Jakobson
Tallinn School of Economics and Business Administration,
Tallinn University of Technology
101 Kopli, 11712 Tallinn, Estonia
e-mail: indrek.jakobson@ttu.ee

Valter Ritso
Tallinn School of Economics and Business Administration,
Tallinn University of Technology
101 Kopli, 11712 Tallinn, Estonia
e-mail: valter.ritso@swedbank.ee

Abstract
The main aim of the article is to emphasise the need for governmental support in the
process of building knowledge-based economy. The authors focus on the knowledge
creating process in the form of R&D activities and also on entrepreneurial process,
mostly in participation with universities. That means an analytical description of the
survey provided by the Ministry of Economic Affairs and Communications of Estonia,
outlining the major barriers to this process, proposes the main directions for
development through business development of innovative and knowledge-based
companies and also the survey conducted in Tallinn University of Technology about
academic entrepreneurship. The authors are going to analyse companies’ cooperation
with universities for better utilisation of their R&D possibilities, entrepreneurial attitude
of universities and also to find out possibilities how further activate the stronger
cooperation with universities in Estonia for better collaborative research. On the
contrary, university as a partner for entrepreneurs is getting the possibilities to enhance
the awareness of science-intensive entrepreneurship.

JEL Classification numbers: L26; I23; O32; O38

Keywords: Research and development (R&D), innovation, technology transfer,
knowledge transfer, academic entrepreneurship, spin-off, supporting measure
1. Introduction

There are a lot of theories seeking to answer the key question what is the driving force behind economic development and wealth in the modern era. Over all these theories hovers the question: how important are Research, Development and Innovation in the process of creating additional value and new enterprises? If they are important, how can central or local government support this process without contradictoriness with generally accepted principles of supporting private businesses and EU regulations, especially in the field of state aid? How effective really are governmental policies and measures? In fact, we have no good gauges to measure it. In this paper the authors try, by illustrating the case of Tallinn University of Technology (TUT) and Estonia as a whole, to analyse the impact of Estonian research and development (R&D) supporting measures to achieve higher levels of academic and innovative entrepreneurship with more active and effective technology transfer between university and industry.

Technology transfer is frequently thought of as occurring within or across firms, such as the dissemination of information through transfers of employees from one division or country to another (intra-firm transfers of technology) (Siegel et al. 2003). But it can also be depicted more broadly, conveying international movement of all possible knowledge and know-how. Indeed, much research has focused specifically on the flow of technology transfer within a large R&D organization, or from an R&D subunit to the larger organization (Allen 1984).

Academic entrepreneurship may be perceived as a fairly wide concept including all types of entrepreneurial activity conducted by academic people, not as a spin-off creation that is a new company founded to exploit a piece of intellectual property created in an academic institution (Spilling 2007, Shane 2004). That is one reason why we can have the connection with R&D in universities and academic entrepreneurship, even though some authors have defined spin-offs as companies founded by anyone who has worked at a university (Roberts 1991, Shane 2004). In the context of this paper the main emphasis is on the R&D activities and innovative academic entrepreneurship. The authors intend to give an overview of academic entrepreneurship in Estonia, using TUT as an example due to the confidence that TUT is adequately representative in the current field, being the second largest university in Estonia, and the largest technical university, which should provide ample opportunities for technology transfers and new venture creations.

Questions about sources of economic growth, the rate of technological change, the competitive position of different firms and countries, the dynamism of alternative industrial structures and arrangements all tend to revolve around notions of differential inventiveness: What has happened to the "underlying" rate of technical and scientific progress (Griliches 1990)? Research and development, resulting in new goods, new processes and new knowledge, is a major source of technical change (Guelllec and van Pottelsbergh de la Potterie 2001), and economic theory point to technical change as the major source of productivity growth in the long run (Solow 1957, Romer 1990). Allegedly an increase of 1% more in public R&D generates 0.17% in productivity growth. Understandably there exist numerous contrary examples in global practice as well, thus the authors emphasise the importance of a specific support measure, and the way how exactly R&D related funds are allocated and to which support measures they are channelled. The effect is larger in countries where the share of universities (as opposed to government labs) is higher, in countries where the share of defence expenditure is lower, and in countries which are intensive in business R&D (Guelllec
and van Pottelsberghe de la Potterie 2001). Also, R&D numbers may be overestimating the real growth in inventing input. Moreover, it is not obvious that we need a growing number of inventions to sustain our current rates of growth, or that we should worry too much about the rising rate of foreign inventions. We are likely to be their ultimate beneficiaries (Griliches 1990). R&D activities of universities and other Public Research Organizations (PRO) that are a basis for knowledge-based entrepreneurship, as well as university-based entrepreneurship – having a significant impact on promoting country’s overall competitiveness – require thus further in-depth studies.

The European paradox – which sounds quite similar to the earlier "UK paradox" fashionable around thirty years ago – refers to the conjecture that EU countries play a leading global role in terms of top-level scientific output, but lag behind in the ability of converting this strength into wealth-generating innovations, is essentially not a problem only in Europe (Dosi et al. 2005). Universities have acted traditionally as passive repositories of scientific know-how, which can be queried upon demand (Geoghegan and Pontikakis 2008). In the 1970s, American universities were criticised for being more adept at developing new technologies than moving them into private sector applications and after that, in 1980, Congress attempted to remove potential obstacles from university to industry technology transfer through legislation, which became known as the Bayh–Dole Act (US General Accounting Office 1998). Similar actions were undertaken in 1999 by the government of Taiwan by implementing the basic law on science and technology, which reorganised the management of intellectual property rights in public institutions (Horng et al. 2005). There has been a rapid rise in commercial knowledge transfer from universities to practitioners or university–industry technology transfer (UITT), through licensing agreements, research joint ventures, and start-ups and an impressive rise in UITT activity, as evidenced by an increase in the number of patents granted to US universities from about 300 in 1980 to approximately 3700 in 1999, and a threefold increase in licensing of university-based technologies to firms since 1991 (Siegel et al. 2003). Annual streams of revenue accruing from these licences have risen from about US$160 million in 1991 to US$862 million in 1999, now constituting about 2.8% of university R&D expenditures (Siegel et al. 2003). As a negative epiphenomenon there, the expansion of US university patenting has resulted in a rapid decline of the patent quality and value (Henderson et al. 1998). In their research on the role of university technology transfer offices Sharma et al. (2006) modified a categorization originally developed by Upstill & Symington (2002) to describe three different modes of UITT, namely: non-commercial transfer, commercial transfer, and new company generation (Figure 1). Such categorization helps to understand that UITT is not conducted solely within commercial rules and legislation, but instead the flow of knowledge and know-how can take place in an informal environment as well.

Numerous products in a wide variety of key strategic high-technology industries (e.g., computers, pharmaceuticals, biotechnology, and instruments) have been developed through UITT. These include internet search engines (e.g., Lycos), the Boyer–Cohen "gene-splicing" technique that launched the biotechnology industry, CAT scanners and environmentally friendly technologies (US General Accounting Office 1998). Academic enterprises are contextualised as one form of this transfer process. Contrary to popular wisdom, technology transfer does not flow strictly in one direction, i.e. from firms to universities; it has much wider and stronger impact on economic development in countries and regions (Siegel 2003).
Estonia is one of the European countries which have substantially higher proportion of small and medium sized enterprises (SMEs) that contribute actively to national economy. This sector generates new innovations primarily based on the knowledge originated from universities (Acs et al. 1994). Kaseorg and Sakk (2001) point out that 99.4% of Estonian companies are SMEs with up to 250 employees. This share also includes sole proprietorships. Thus, it can be argued that their role in the national economy is decisive. The reason is that expenditures made by universities serve as an input to generating innovative activity in small enterprises which have any type of collaboration with university. Small firms have a comparative advantage at exploiting spillovers from universities’ laboratories (Acs et al. 1994). A similar advantage is being used also by large enterprises whose research units develop technologies which in many cases have been first explored by public research (Guellec and van Pottelsberge de la Potterie 2001). Spin-off enterprises by definition are operating close to universities, thus being greatly exposed to all R&D activities executed in and around the campus area.

University spin-off firms can be considered as one implication of technology spillover from public research organizations. Mustar et al. (2008) imply that European countries have long been searching for an efficient way of transforming research results into high-growth firms strongly by emulating the success of the US. The increase of European universities’ spin-offs has been accelerated by three factors: first, the increase in ownership of intellectual property rights by technology transfer offices relative to that of faculties; second, the increasing institutional pressure on public research organizations to commercialise research; and third, availability of public funds aiming at financing and knowledge gaps, especially in the last two factors. The authors are confident that Estonia has been subject to similar development trends and problems. Acknowledgment of such market failures by the European Commission has created the preconditions for applying and implementing structural funds in order to support the positive development trends. On the other hand, Mosey et al. (2006) imply that despite an increase of government funded intervention schemes there are still attitudinal and operational barriers that constrain university technology transfer in the UK. Fellowship schemes in conjunction with networks set up between academics, lawyers, accountants,
and financiers are seen as one possible catalyst in order to inspire university research personnel towards commercialization of their research findings (Mosey et al. 2006).

It is therefore important that government ensures dense relationships between public and private research, so that knowledge flows more easily between the two sectors (Guellec and van Pottelsberghe de la Potterie 2001). One example of enhancing technology-based development of a region is development of science parks. Such parks contribute to fostering technological innovation and transfer. Science parks are an effective way to encourage knowledge transfer between academic institutions and knowledge-intensive establishments, thereby resulting in start-ups and growth in science-based or high-technology sectors (Hommen et al. 2006). Another viewpoint of regional know-how consolidation and development has been studied by Meyer (2006) in his paper on “learning regions” using Canada’s IT sector SMEs as the basis of his studies. He states that the key player in technology centre creation is National Research Council, whose goal is to create technology clusters that incite the formation of spin-off companies and start-up firms so that eventually a critical mass of people, expertise, capital and entrepreneurial drive is created through which entire region can prosper.

Education and science policies in Estonia fall under the responsibility of the Ministry of Education and Research, while the Ministry of Economic Affairs and Communications is responsible for innovation and technology policy. The Research and Development Council (RDC) is the main strategic advisory body. The main national agency implementing innovation policy is the Enterprise Estonia (Trendchart 2006). Some measures of those policies are analysed and assessed in the current paper.

The main resources in Estonia for financing research and development (R&D) activities are targeted financing, baseline funding, R&D grants, centres of excellence, maintenance of the R&D infrastructure, national research and development programmes, support programmes for innovation (Ministry of Economic Affairs and Communications and Enterprise Estonia), other programmes from EU structural funds and EU RD&I programmes. Nearly half of all expenditures for R&D come from the Ministry of Education and Research budget. From among the above-mentioned the R&D support programmes are one target for our research and serves as one source for data and analysis in this paper.

The paper describes first the research, development and innovation policy in Estonia, including measures initiated by the European Union. Secondly, the impact of these supporting measures on RD&I and entrepreneurial activity is characterized on the example of TUT, followed by an overview of entrepreneurial activity of the university’s academic staff, SPINNO programme, academic entrepreneurship and spin-offs. The paper ends with conclusions.

2. Overview of Research, Development and Innovation Policy in Estonia

National innovation systems (NIS) are difficult to describe, and more difficult to evaluate, but the term refers to the complex set of formal and informal relationships between the various actors with roles in supporting and implementing innovative activities (Brighton & Kells 2007). There are a number of documents targeted to support science-intensive and innovative entrepreneurship like “Knowledge-based Estonia 2002-2006” (KBE I), “The Estonian National Development Plan for the Implementation of the EU Structural Funds – Single Programming Document for 2004–2006” and its measures for the promotion of research and development and innovation.
Programmes and measures that support innovation can be divided into two groups: programmes that are primarily targeted at enterprises, and programmes that are primarily targeted at Public Research Organizations (PRO-s). There are several supporting measures in Estonia for entrepreneurship like start-up and growth support to a starting entrepreneur, export marketing programme; consulting programme and R&D financing programme. Although only the last-mentioned one has direct relationship with academic entrepreneurship, the other measures have indirect impact on it. It was through these measures that entrepreneurial policy was applied during the period under investigation. To achieve better results in creating new technologies it is essential to have cooperation between the above-mentioned two types of programmes. Spinno Programme is the core of linking universities and entrepreneurship in Estonia (Venesaar & Jakobson 2006), mainly targeted at universities and universities of applied science.

The first document informing about Estonia’s research, development and innovation (RD&I) policy in the pre-accession and first period of using structural funds is the Knowledge-Based Estonia (KBE I), which was adopted in 2001. It is the strategy for RD&I that defines goals, opportunities and principles of promoting Estonian R&D and is the basis for arranging the activities for the coming years by solidifying the framework and volume of public sector support mechanisms until 2006. It sets out the strategic objectives for Estonian RD&I, which were updating the pool of knowledge with the main focus on raising the quality and level of scientific research and increasing the competitiveness of enterprises.

Designing a connecting mechanism between scientific research, development activities and entrepreneurship that fosters implementation of scientific research results in enterprises and society as a whole, is a precondition to increasing competitiveness of enterprises through renewed knowledge base. Only after such a mechanism is in place and operational it is possible to really transfer knowledge to economy and society. In order to achieve these targets it is essential to have highly qualified and motivated specialists intertwined with continuous development of human resources. As no small country can be successful in all RD&I areas and solve all R&D related problems at once, KBE I identified key areas for Estonia and envisaged an increase of resources in such fields. Those key areas are user-friendly information technologies and development of information society; biomedicine and materials technologies. Also national programmes shall be initiated in order to develop the key areas which regrettfully were not developed within the RD&I strategy.

An important element of Estonian national RD&I strategy is the promotion of a knowledge-based society and economy in Estonia. The universities and research institutes have a key role in this strategy both in providing highly skilled graduates and generating new knowledge, but also in the transfer of knowledge, whether generated in Estonia or elsewhere, to businesses and other organizations. In recognition of this role and potential, and also in need to develop capacities, the SPINNO programme was launched in 2001. The programme was funded by the Ministry of Economic Affairs and Communication and managed by Enterprise Estonia. The objective of the SPINNO programme was to enhance cooperation between the business sector and research and development institutions, strengthen the ability of research and development institutions to participate in this cooperation and manage the innovation process.

KBE II (for years 2007-2013) envisages that the broad strategic thrust of KBE I will continue and this will require universities to engage further with the business sector. Academic staff may, and should, draw on other sources of business support, where appropriate, but there are some components of the commercialization process which can be delivered most cost-effectively from within the institution (Brighton &
Kells 2007). The strategy sets out three main objectives: the competitive quality and increase in the volume of research and development; innovative entrepreneurship creating new value within the global economy, and an innovation-friendly society aimed at long-term development.

Also the European Commission has set in its recommendations a need for better links between public research organizations, including universities, and industry that can facilitate the circulation and use of ideas in a dynamic knowledge society and in enhancing competitiveness and welfare. Therefore, public research organizations need to disseminate and more effectively exploit publicly-funded research results with a view to translating them into new products and services. Means to realise this include in particular academia-industry collaborations – collaborative or contract research conducted or funded jointly with the private sector – licensing, and the creation of spin-offs (Commission 2008). Results of the above-mentioned policies are reflected in R&D activities of enterprises and universities as well as in the establishment of new knowledge-based enterprises.

3. Methods and Data

The current paper is using several studies as a database, which helps explain Estonia’s position within corporate R&D activeness, governmental and foundation-based supporting measures for further enhancing current R&D activity, which in turn illustrates entrepreneurial initiative of enterprises and their potential for further development. Based on the assessments given to these studies the authors have tried to analyse the implementation of supporting measures for RD&I and development of academic entrepreneurship in TUT serving as an example for entire Estonia, as a part of knowledge transfer operations.

An empirical study conducted at TUT describes the results of supporting measures of Estonian innovation system that have been realised in the field of technology (knowledge) transfer and as a part of it, academic entrepreneurship. This study also serves as a source for assessing the impact and implementation of the SPINNO programme in years 2001-2006 provided by Robin Brighton and Andrea Kells (2007).

A special study has been initiated in TUT in order to evaluate entrepreneurial initiative of the university staff, focusing on the time period of 1996-2007. All members of TUT staff holding a valid work contract with the university at the moment of conducting the study were considered as subjects of this study. Students of TUT were left out of the study’s scope. Information for the study was gathered based on data of the Estonian Central Commercial Register. The authors recognise that there may be statistical errors in this study due to the possibility that not all enterprises might have updated their status information in the central registry regarding, e.g. board members and some other characteristics. This study also depicts the officially registered TUT spin-off enterprises, and evaluates their share in total entrepreneurial activities of the staff members of TUT.

4.1. Support Measures and Corporate Activeness in R&D

The share of R&D expenditures in the national GDP of Estonia has increased by virtue of Lisbon declaration principles (2000), as well as the so-called „Aho Report“. Expenditures made by the government on R&D (GERD) as percentage of GDP is the most commonly used indicator for international comparisons and for defining national policies for science and therewith government expenditures on R&D and business expenditures. At the beginning of the period under investigation (2000) Estonia’s share of R&D expenditures in total GDP was 0.61%, whereas in 2006 the share already rose to the level of 1.14%. The share has thus been almost doubled during the period. In comparison with the neighbouring Nordic countries, Estonia’s level is quite low. Estonia should achieve the share of R&D expenditures in total GDP of 3% set as a target in Lisbon strategy according to the KBE II document by 2014, including private sector R&D 1.6% of GDP and public expenditure on R&D 1.4% of GDP (Knowledge-based Estonia II).

Financing Research & Development Programme is one of the RD&I support measures operated by Enterprise Estonia. The aim of this programme is to enhance the competitiveness of enterprises and promote establishment of new technology-based innovative enterprises through supporting development of new products, services, technologies, new processes, or significant improvement of existing ones. Under this programme there are three types of support measures: pre-study support, public research organizations’ applied research support, enterprise’s applied research and/or product development support (Jürgenson 2007). During the period of 2001-2005, the programme had the following main parameters as illustrated in Table 1.

| Table 1. Budget and Amount of Applications/Supported Projects during 2001-2005 |
|-------------------------------------------------|-------|-------|--------|
| Budget (MEUR)                                     | 15.3  | 14.6  | 29.9   |
| Applications                                     | 21.5  | 21.4  | 42.9   |
| enterprises (MEUR)                               | 13.7  | 14.4  | 28.1   |
| from PROs (MEUR)                                 | 7.8   | 6.6   | 14.4   |
| Positive decisions                               | 10.3  | 13.4  | 23.7   |
| enterprises (MEUR)                               | 7.4   | 9.4   | 16.8   |
| PROs (MEUR)                                      | 2.9   | 4     | 6.9    |
| Number of applications                            | 165   | 153   | 318    |
| from enterprises                                 | 123   | 107   | 230    |
| from PROs                                        | 42    | 46    | 88     |
| Number of positive decisions                      | 107   | 107   | 214    |
| enterprises                                      | 82    | 72    | 154    |
| PROs                                            | 25    | 35    | 60     |

Source: Jürgenson 2007; authors’ calculations
Note: Budget information based on National Audit Office of Estonia data, applications and results information based on Enterprise Estonia data (2006).
The amount of national support given to enterprises and PROs is roughly 10% of total RD&I expenses that Estonian enterprises have incurred during 2001-2005, although the number of parties that have received support is quite insignificant. The following conclusions can be drawn from the evaluation report of R&D financing programme (2001-2003):

- Private enterprises apply more actively (66% of the applications) for R&D support financing than public sector PROs (34% of the applications). This gap is even more evident in the split of financing decisions made – 71% of the funds went to private enterprises, and 29% to public PROs.
- Almost 79% of the enterprises who received support financing admitted that they either certainly or most likely would have undertaken the development project anyhow, even without receiving national support. On the other hand, only 33% of the PROs stated the same, indicating thus more acute need for governmental support financing of R&D activities in the public sector itself.
- From all enterprises who received support financing, 86% considered the project undertaken as successful from technology development point of view. Alas, only 48% admitted that the project undertaken was economically successful (Jürgenson 2007). This indicates rather clearly that development of new technologies and/or new products alone does not necessarily increase the enterprise’s competitiveness. Especially in the case of start-ups, SMEs, and spin-offs there is also a severe need for governmental support financing for next steps in the process of bringing a product or service to market, e.g. industrialization experiments, production capacity building, building up marketing and sales strategies, etc.

### 4.2. Entrepreneurial Activity of University’s Academic Staff and SPINNO Programme

A study has been conducted based on data of the Estonian Central Commercial Register to illustrate the entrepreneurial activity of TUT members, which serves as an important database for comparisons with spin-off activity of TUT members. A total of 1860 employees of TUT were examined. The study identified 890 different cases of TUT staff members participating in enterprises; of them 400, or slightly under half of all cases, had some share of ownership in the enterprise (Table 2). The study excluded all cases where a member of TUT staff was holding a share of ownership in a publicly listed company, since in such cases the size of ownership share was minuscule, and did not allow to affect the operations of the company.

From the methodological aspect, it is important to mention that the number of enterprises existing currently is not clear. Table 2 does not allow drawing any conclusions about the vitality of established enterprises, but since it does reflect the overall entrepreneurial activity, it is possible to highlight some indications. It should be pointed out that compared to the number of registered TUT spin-off enterprises (12), which are discussed in greater detail in Section 4.3, the total number of enterprises with TUT staff members’ ownership (in 77% of the cases partial ownership) is 400. In comparison with the ratio of 1 spin-off enterprise to 4 academic enterprises identified by several researchers (Allen & Norling 1991), it can be stated that a similar ratio in the case of TUT, based on the number of registered enterprises with TUT staff members’ ownership, is 1:33, which suggests significantly above average entrepreneurial activity.
Table 2. TUT Staff Entrepreneurial Activities

<table>
<thead>
<tr>
<th>Status of academic staff members</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Companies created 1995-2007</td>
<td>% of total number of employees</td>
</tr>
<tr>
<td>Members of council</td>
<td>196</td>
</tr>
<tr>
<td>Members of board</td>
<td>453</td>
</tr>
<tr>
<td>Other key positions</td>
<td>388</td>
</tr>
<tr>
<td>Owners total</td>
<td>400</td>
</tr>
<tr>
<td>Ownership share 100%</td>
<td>92</td>
</tr>
<tr>
<td>Ownership share 50-49%</td>
<td>84</td>
</tr>
<tr>
<td>Ownership share 0-49% and with unknown share</td>
<td>224</td>
</tr>
</tbody>
</table>

Source: Estonian Central Commercial Register, authors’ calculations
Note: The table lists all cases where enterprise has been registered in the commercial register, although the number of operating enterprises is smaller.

with lower than average number of spin-off enterprises. However, it should be pointed out that the number of operational enterprises is significantly lower, and therefore any assumptions based on this ratio in the current set-up would be premature. The elaboration of TUT staff members’ entrepreneurial activity will be continued. We should also stress that the ongoing entrepreneurial activities of TUT staff members are usually not knowledge based, and the university has very limited control over such activities, as a result of which it is suffering from significant loss of potential income. At the same time, the university is not providing greater level of support to enterprises owned by its staff members than other non-university related enterprises would receive from the means of SPINNO programme.

Pre-studies conducted by Technopolis, an international innovation policy consultancy firm, and Katholieke Universiteit Leuven (KU Leuven), which indicated that in 2000 Estonia was significantly lagging behind other European Union member states in commercialising R&D results, prepared the initiation of SPINNO programme in Estonia (de Jager et al. 2001). SPINNO was launched by Enterprise Estonia (EAS) in 2001-2006 with the aim of strengthening the national system of innovation in Estonia and in turn, help to increase the competitiveness of the Estonian economy through the development of new science-intensive economic activity. The programme that included a number of projects was funded by the Phare programme and Structural Funds, as well as by the Estonian Government. The lower level objectives of SPINNO in Estonian research and development institutions and universities of applied sciences are: create a favourable business environment; developing the ability to respond more effectively to the needs of businesses and society, and increasing the revenues received from the implementation of knowledge and research and development results. 7 universities participated in the SPINNO Programme. SPINNO programme had a budget of 2.3 MEUR during the period 2001-2003, and 3.858 MEUR in 2004-2006. Thus the overall budget of SPINNO programme for both periods summed up to 6.158 MEUR¹.

¹ As the programme periods do not coincide with calendar years, and some amount of support financing was pushed out to 2007 without having the final report of the last programme period (2006) available, the data are preliminary.
Table 3 shows the aggregate results for the entire SPINNO programme. The main result until 2006 was the rise of income from R&D contracts with businesses (from 1.221 MEUR to 3.69 MEUR annually), income from consultation and training services (from 0.262 MEUR to 2.28 MEUR) and increase of licences from 3 to 13. With the exception of two results – number of spin-off enterprises established, and number of licences granted – the result met the expectations. At first glance it might seem that the number of patents granted is decreasing, but it should be noted that the table illustrates the annual number of new patents granted, not total number of patents granted. On the other hand, SPINNO programme results are times lower than those of ASTP\(^2\) (Association of European Science and Technology Transfer Professionals) universities, when comparing 2005 data of the number of licences granted – on average 1.3 new licences per year, and on average 10 new licences per year, respectively. Average annual income from realizing licence agreements of an ASTP university exceeds that of a SPINNO university nearly 47 times (comparative data are partly based on calculations by Brighton & Kells 2007)! In particular, the average total R&D expenditure of ASTP member universities is around 17 times greater than that of SPINNO participant universities, which undoubtedly is the main reason for a dramatic gap in the applicable results of the two groups of universities under comparison (Brighton & Kells 2007).

### Table 3. Outputs of the SPINNO Programme for the Period 2001-2006

<table>
<thead>
<tr>
<th>Year / %</th>
<th>Outputs of all SPINNO programmes</th>
<th>Outputs of TUT</th>
<th>Change %</th>
<th>Change %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2001</td>
<td>2006</td>
<td>Change</td>
<td>2001</td>
</tr>
<tr>
<td>Income from R&amp;D contracts with businesses (MEUR)</td>
<td>1.22</td>
<td>3.69</td>
<td>202</td>
<td>0.91</td>
</tr>
<tr>
<td>Patents granted</td>
<td>5</td>
<td>8</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>Licences granted</td>
<td>3</td>
<td>13</td>
<td>333</td>
<td>2</td>
</tr>
<tr>
<td>Income from realisation of IP (’000 EUR)</td>
<td>177.61</td>
<td>203.56</td>
<td>15</td>
<td>1.92</td>
</tr>
<tr>
<td>Income from consultation and training services (’000 EUR)</td>
<td>262.04</td>
<td>2279.60</td>
<td>770</td>
<td>242.86</td>
</tr>
<tr>
<td>Income from analysis and testing services (’000 EUR)</td>
<td>220.56</td>
<td>361.68</td>
<td>64</td>
<td>123.73</td>
</tr>
<tr>
<td>Spin-off businesses established</td>
<td>5</td>
<td>10</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>Spin-offs existing for 3+ years</td>
<td>7</td>
<td>29</td>
<td>314</td>
<td>6</td>
</tr>
</tbody>
</table>

Source: Brighton & Kells 2007; author’s calculations

Note 1: 2004 and 2006 are incomplete because projects did not disclose data for those years. Not all projects provided actual outputs for 2001-2003.

Note 2: Data for TUT in the fields of „Licences granted“, „Income from realization of IP“ and „spin-off businesses established“ are not available for years 2001-2002. The year 2003 has been used as the starting point.

\(^{2}\) The Association of European Science and Technology Transfer Professionals (ASTP) is a non-profit organisation founded in December 1999, through the initiative of a multinational group of technology transfer professionals. It is based in the Hague, the Netherlands. The group aims to professionalise and promote technology and knowledge transfer between European scientists and industries from around the world. ASTP is growing rapidly, and currently has more than 500 members from 35 countries.
Much of the activity within the SPINNO projects so far has been aimed at developing the universities’ capacities to respond to enterprises’ needs and to engage proactively in knowledge transfer. SPINNO activities include: developing rules and regulations governing the handling of IP and engagement with enterprises; marketing knowledge transfer capabilities; training academic staff, and sometimes also students to engage with enterprise and providing direct support and assistance in many cases; establishing technology transfer offices that will act as focal points for external organizations, but also for academic staff. The aforementioned activities have created a favourable environment for entrepreneurship in universities. The activities undertaken to increase entrepreneurial awareness and fostering the favourable environment have had in addition to direct and measurable impacts also significant positive side effects, although the relation to such activities is not easily proven.

4.3 Tallinn University of Technology SPINNO Case

Tallinn University of Technology (TUT) has received funding for the SPINNO programme since 2001. The overarching aim of the SPINNO project in TUT is to increase entrepreneurial culture. SPINNO activities in other universities are also targeted to reach similar objectives. Relatively large volatility and unstable representation of different PROs in the study characterise the dynamics of the entire SPINNO programme since its initiation in 2001. Of course, the rise in many indicators is significant. At the same time, many of the outputs are low in absolute sense (Brighton & Kells 2007).

One of the main and probably the most important measures for achieving better results of SPINNO programme was creating a technology transfer office, named the Technology and Innovation Centre (TIC), with its own staff in 2005. Nearly half of the staff of the TIC have their first degree in a business-related qualification. The mission of TIC in TUT is to develop and offer services supporting new innovation in R&D activities, and improvement in the results of technology transfer and R&D activities through these services. The main activities TIC is involved in are creating a favourable environment in TUT for knowledge transfer and commercialization of the R&D results; active offering of TUT competencies, services, co-operation opportunities, and intellectual property; development of networks that enable R&D activities; and supporting and developing the establishment of spin-off enterprises.

The most interesting activity of SPINNO for TUT was supporting the establishment of spin-off companies. When SPINNO was started, during the first two years there were no spin-off companies established. Until the end of 2003 there were 6 spin-off companies established, but in reality they were reformed or re-established existing companies. From then on the number of spin-off enterprises created has levelled off at the average level of 1-2 new spin-off ventures per year. The spike in 2003 was due to the exceptional situation created by the active launch of SPINNO programme, which resulted in realization of the entire existing potential of establishing spin-off enterprises. Furthermore it should be noted that during the period of analysis, TUT has had a share of ownership in one (currently in two) spin-off enterprise only, and TUT has so far not earned any profits from spin-off entrepreneurship.

The authors have conducted a qualitative study (not enough data for quantitative study available) in order to investigate the main difficulties related to establishment of spin-off enterprises. Creating spin-off enterprises has involved quite many problems and their identification has been a task throughout the entire SPINNO programme period. Interviews with spin-off entrepreneurs indicate that the most crucial
problem is a gap in financing and other support measures, especially in the period after setting up a company. National entrepreneurial support structures can offer only most limited help in this stage due to the current legal framework. According to one entrepreneur, realization of all promising business ideas will stop in this period. After a spin-off enterprise has become a lucrative target for venture capitalists (not seed and pre-seed capital) to invest in, the need for involving additional funding decreases dramatically, changing thus the initial situation where start-up enterprises’ competition for funding is substituted by venture capitalists’ competition for potential investment projects.

Additionally, although less frequently mentioned but not a less important problem is the conflict of interests between the university and the academic entrepreneur. From interviews conducted with university staff members under whose jurisdiction a classical university-knowledge-based spin-off enterprise has been established, a problem has surfaced. Namely the fact that the academic entrepreneur is essentially, although not always formally, lost for the university as a lecturer and scientist. “He is really no more a professor and all the little he does here, causes just only the problems for the institute”, a dean said about one successful spin-off entrepreneur. Keeping its scientists is currently much more important for the university than supporting spin-off entrepreneurship, which is very unlikely to involve any profits in the future.

5. Conclusions

The paper analyses various supporting measures for RD&I and the relations of these measures with entrepreneurship development. The authors have monitored the status of academic entrepreneurship in Estonia on the example of Tallinn University of Technology, and have presented preliminary study results in this paper. The paper further acknowledges a firm connection between knowledge-based entrepreneurship at universities and national support measures. On the other hand, R&D institutions, especially universities, knowledge-based enterprises established by them and their members still do not seem to play any significant role in Estonian economy – otherwise a quite widely spread phenomenon of small countries. Information available to authors does not allow making definite conclusions as to whether Estonia is indeed exceptional, considering the fact that the role and status of spin-off enterprises in Central and Eastern European countries differs from Western European countries, mainly in the fields of financing and legal framework. This topic definitely needs further investigation and analysis.

High level of entrepreneurship among university staff members does not necessarily refer to active spin-off entrepreneurship. Having analysed the hindrances to starting a new enterprise, further obstacles have arisen in relation to knowledge-based entrepreneurship – namely the conflict of interests between PROs and their member entrepreneurs in addition to the lack of early stage financing. Inability of the involved parties to settle this conflict of interest has severely discouraged establishment and efficient management of spin-off enterprises where university would have at least some share of ownership. The authors hereby acknowledge that a satisfactory level of support for academic entrepreneurship has been established through national support measures (but a gap in financing still exists), and that this level must be kept up, but there is currently no indication of a quantitative leap forward in the nearest future. The comparison between SPINNO and ASTP in this paper indicates that successful utilization of R&D results in commercial sector in future (in various ways, not only
through establishment of spin-off enterprises) will be directly dependent on the amount of funds channelled to R&D activities. To summarise, the authors have demonstrated that national support measures targeted at developing knowledge-based entrepreneurship have been operated efficiently, although not perfectly, and that in the future there is a need to focus on preserving these measures while continuously increasing funding for R&D activities, which through side effects should provide also a solution to other obstacles currently hindering knowledge-based entrepreneurship.

The current paper describes mostly entrepreneurship related issues, but does not offer an answer to the question how to find out possibilities that could additionally foster stronger co-operation between enterprises and universities in Estonia. Co-operation between enterprises and public research organizations has increased significantly during the period under discussion, but the root causes to such phenomenon require further studies. Moreover, the authors acknowledge that information on which the paper is built on is insufficient to determine whether the governmental political methods have been efficient, or the abovementioned positive changes have taken place independently. Furthermore, it is necessary to investigate in greater detail the causal effect of governmental R&D supporting measures on the intensity of academic entrepreneurship.

As a conclusion the authors would like to state that the study for evaluating TUT staff members’ entrepreneurial activity and applying the results of R&D supporting measures will be continued, and a future objective is to conduct similar studies in all other universities which have been or will participate in SPINNO programme. Analyses of the results of these future studies will enable to make conclusions and suggestions for developing Estonian entrepreneurial policy in the field of academic entrepreneurship.

6. References


http://www.akadeemia.ee/_repository/File/alusdokud/Knowledge-based Estonia II.pdf


