# Commercialising research results in immature technology transfer markets: cases from the Greek experience

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**Abstract:** Transnational technology transfer (TTT) is a key mechanism for the exploitation of technological innovation. This paper's aim is to investigate the development of TTT strategies in immature technology transfer (TT) markets as a key means to improve local technology and industrial potential. The paper detects obstacles in the TTT process in an immature TT market such as Greece and identifies schemes and mechanisms such as spin-off creation, start-up co-location, partnership building abroad, multisource fund raising and effective brokerage services that can contribute to the TT market growth and the effectiveness and success of TT agreements. The findings show that all these mechanisms include internationalisation as a main component and ultimately as their key success factor.

**Keywords:** research results commercialisation; immature technology transfer markets; innovative entrepreneurship; spin-off firms; Greek start-ups.

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## 1 Introduction

Over the last 20 years or so, the European Commission (EC) has shown a pronounced interest in strengthening the technological research potential of the Union and encouraging innovation in business and industry, thus, coping with the so-called 'European paradox'[1] (Dosi et al., 2006). Initially, in the mid '90s, due to EU's loss of global competitiveness, especially in traditional industries, low growth and high unemployment levels, the EC and policy makers from various political persuasions, in alignment with the academia, were forced to acknowledge that local growth and global competitiveness of regions is driven by technological innovation and dynamic entrepreneurship (Acs and Stough, 2008; Acs et al., 2004; Romer, 1990; Olson, 1996).

At the 2002 European Summit in Barcelona, heads of Member States, under the influence of the Lisbon strategy agenda (2000)[2], set the target of RTD expenditure at 3% (2% from business and 1% from public funds) of the EU gross domestic product (GDP) by 2010 (see European Commission, 2002a). Every year, almost three billion euro are invested by the EC in RTD projects through the European Union framework programmes for RTD (details can be viewed at the European Union RTD, 2008), while the Member States raise further this amount through various other national funding schemes. Participation of the private sector ranges from 25% to 50% of the total research

budget, according to the individual organisation status (i.e., SME or not) (for details, see RTD FP participation rules).

Despite the raise in research funding, as the unsatisfactory results halfway to the 2010 Lisbon and Barcelona targets suggest, the EU and many of the Member States, although rich in knowledge, did not manage to capitalise on their high R&D results and patents output and exhibited low growth rates (see for example European Commission, 2008b; OECD, 2006). A critical reason for this poor record, as several studies indicate, is that each country, although unique, in order to enable productivity growth, needs to consider in the overall growth policy agenda integrated supportive measures not only for the supply side of the technology, that is for knowledge producers (i.e., scientists and engineers, R&D labs, intellectual property rights organisations and high-tech industries), but also for knowledge users (i.e., business start-ups and growing firms) (see for example Wong et al., 2005). It has been also suggested that a vital role to this end can play better technology transfer (TT) initiatives and industrial linkage (Geh and Smith, 2001; Camp and Sexton, 1992).

Transnational technology transfer (TTT) in the market is long assumed as a key mechanism for the exploitation of technological innovation (Keller and Chinta, 1990). However, the EU, following the trend established in the US in the '80s through the enactment of the Bayh-Dole Act, actively encouraged the transfer of publicly funded RTD results in commercial ventures [university and research and technology organisation (RTO) spin-offs] from 2002 onwards (see EC, 2002b). Consequently, technological innovation has become the focus of several post-RTD support measures at European and national level. The 'exploitation of research results', 'bridging the gap between research and industry', 'TT' and 'technology commercialisation' are some of the terms heavily used today to define the steps required to be taken so that technological research contributes not only to the publication and patent record of individual researchers, but also to potential for future relationships, entrepreneurial dynamism and social wealth.

Yet, it appears that effective new technologies transfer practices (i.e., the management of the tools used to transfer emerging technology from the technology providers to technology users) and especially successful commercialisation processes (i.e., the start-up of a spin-off venture) have not the expected performance (Markham, 2002). The basic reason for this dismal outcome is multilateral. Effort to take the scientific and technological knowledge outside the laboratory of the technology developer and driving it into the marketplace is considered a complicated process (Allen, 2003). It involves several players ranging from technology providers and technology users (industries and SMEs) to investors and brokers and requires positive socio-economic environment. It needs innovation policies (a set of legislative measures, funding programmes and other incentives) to encourage the use of the research results for the benefit of businesses and the society in general.

Furthermore, as empirical evidence indicates, the successful outcome of a TTT agreement (and the venture will stem from it) depends on various parameters such as the technology itself, its market potential and the willingness of the involved parties, their business culture, the infrastructure and mechanisms existing for facilitating TTT (see for example Teece, 1981). It requires 'mature' markets for TT. Such a maturity can be defined on certain criteria, set out by OECD (2007). These are: RTD and investment in knowledge, human resources in science and technology (S&T), innovation policies and mechanisms, innovation performance, information and communication technologies (ICTs), biosciences and nanotechnologies indexes, industrial production, productivity and

trade, etc. Countries or regions with low RTD potential or conservative business culture and/or inflexible administrative environment may be defined as immature TT markets and Greece is one of them. Greece, although an EU member state since 1980, has a weak RTD tradition and poor performance in the above mentioned criteria (see EC, 2008a, 2008b). However, it possesses several pockets of excellence in RTD performance and RTOs with international reputation, while the brain drain of the '50s to'70s has today been inversed (see for example IOBE, 2008).

The question is how countries with immature technology markets can effectively organise their TT attempts and achieve successful TT agreements. Our goal is to shed some light on how to develop successfully TT polices in immature TT markets such as Greece, as a key means to improve local technology and industrial potential. We also aim at providing a more informed perspective on how organisations design and implement their strategic interaction portfolio in order to benefit more from the TT agreements. To this end, this paper examines cases of TT involving Greek technology players. Obstacles in the TTT process in the Greek immature TT market are detected, and schemes and mechanisms such as spin-off creation, start-up co-location, partnership building abroad, multisource fund raising and effective brokerage services that can contribute to the TT market growth and the effectiveness and success of TT agreements are identified.

First, we analyse the theoretical framework of TT agreements involving the interaction of universities and research organisations with the technical assistance of the IRS network. Taken the basic theoretical issues into account, we then show how different patterns of interaction have achieved successful TTT agreements. The common denominator in almost all the successfully concluded TT agreements examined is the internationalisation aspect. Finally, we relate all the stages of the analysis to the implications that they have for immature technology markets.

The remainder of the paper is structured as follows. Section 2 deals with the theoretical framework. Section 3 describes the empirical research and analyses the case studies by grouping them in mature success stories (more than ten years of operations) and in ambitious young spin-offs operating in the last six years. This part is followed in Section 4 by a discussion of our findings and their implications for immature technology markets such as Greece. Section 5 presents the concluding remarks and puts some ways forward for policy interventions. Finally, Section 6 offers further research directions.

## 2 Theoretical framework

### *2.1 Literature review*

There are many studies, which have focused on certain dimensions of the TT and specific factors that affect the ability to transfer technology and commercialise successfully the R&D results (see for example Zucker et al., 2002; Siegel and Phan, 2004). Yet, the field is relatively new and evolving (Hollmer, 2003). This paper extends the existing research in the field by exploring issues related to TT strategies in immature TT markets. This has been a matter that has largely been ignored in the context of the mainstream literature in Greece or elsewhere and by this paper, we try to fill in the gap. In giving emphasis on different strategic patterns of achieving effective TTT agreements involving players from immature TT markets, this paper also provides a few answers on practical questions of how organisations at all levels can better exploit technological innovation.

## *2.2 Definitions and TT related issues*

### *2.2.1 TT agreements*

The innovation relay centres (IRCs, 1995–2008) were established with the support of the EC. They are set up to stimulate TTT and promote innovation relay services, which are primarily targeted at technology-oriented SMEs, but are also available to large companies, research institutes, universities, technology centres and innovation agencies. During the 6th Framework Programme for RTD (2002–2006), IRCs have mediated in the successful conclusion of over 2,500 TTT agreements (of which 175 involving Greek organisations), as a result of two major cooperation mechanisms:

- the distribution of 12,000 technology offers and requests in the whole network
- the organisation of hundred of brokerage (partenariat) events which attracted several thousands of SMEs and technology developer clients.

**Table 1** TTT agreements types, reported by the IRCs for the period 2002–2006

| *Agreement type* | *EU27* | *GR* |
|---|---|---|
| Commercial agreements with tech. assist. | 38% | 42% |
| Joint ventures | 3% | 2% |
| Licensing agreements | 9% | 6% |
| Manufacturing agreements | 4% | 5% |
| Technical cooperation agreements | 46% | 45% |

Note: ~2,500 agreements all over Europe, 175 in Greece

*Source:* IRCnet, Help-Forward network (GR)

It is not in the scope of this paper to assess and evaluate the impact of the TTT agreements with respect to their type. However, it should be noted that commercialisation of research results, when they stem from universities and research organisations, can be achieved mainly through specific type of agreements such as licensing and joint ventures. The above mentioned 2,500 TTT agreements involved over 3,700 network clients (each TTT agreement involves two clients and the same client may be involved in more than one TTT agreement) as follows:

**Table 2** Organisations involved in TTT agreements, reported by the IRCs for the period 2002–2006

| *Organisation type* | *EU27* | *GR* |
|---|---|---|
| Universities/research centres | 26% | 23% |
| Industries | 60% | 42% |
| Services, etc. | 14% | 35% |

Note: 3,700 clients in Europe, 185 from GR

*Source:* IRCnet, Help-Forward network (GR)

The market sectors concerned (venture economics industry coding employed) in the reported TTT agreements (one agreement may concern more than one market sector) can be analysed as follows:

**Table 3** Market sectors concerned in the TTT agreements, reported by the IRCs for the period 2002–2006

| *Market sector* | *EU27* | *GR* |
|---|---|---|
| Communications | 10% | 9% |
| Computer related | 22% | 30% |
| Other electronics related | 11% | 3% |
| Genetic eng./molec. biology | 3% | 1% |
| Medical/health related | 28% | 40% |
| Energy | 11% | 7% |
| Consumer related | 27% | 29% |
| Industrial products | 59% | 62% |
| Other (not specified) | 26% | 31% |

*Source:* IRCnet, Help-Forward network (GR)

### *2.2.2 TT players*

The TT process involves the following players: *technology developers and providers* (such as inventors, research organisations, technology-based firms, intellectual property holding firms), *technology recipients* (usually SMEs, industries, but also large organisations), *TT facilitators* (brokers, mediators, technology parks, incubators, etc.), *financial institutions* (banks, investors, venture capital firms, etc.) and *business advisors* (lawyers, business consultants, etc.). TT, as a process, follows specific steps, which are different for the developer and the recipient, as practitioners' experience has shown.

The process flow of Table 4(a) can be applicable in the case of university spin-offs as well: the TT agreement concerns mainly (joint venture) shareholders agreement in which the technology provider joins forces with an industrial partner (active in the same or event different sector) or an investor, so that they jointly market the technology and the related products and services. Thus, the technology recipient becomes business partner to the provider and shares the risk of failure as well as the benefits of success.

Obstacles can be identified for both players at various stages of the process. Collectively, success or failure (at any stage of TT process) may be attributed to some of the following factors:

- the technology itself (validity, suitability)
- the market potential itself (target market size)
- willingness of the parties involved
- business culture (in the RTOs)
- innovation culture (in enterprises)
- policies and legislation
- TT infrastructure and mechanisms
- societal attitude toward innovation
- sufficient business support

- access to finance (and risk culture of the financial institutions themselves).

**Table 4(a)** TT process – provider

| *Other parties involved (provider side)* | *Technology provider* |
|---|---|
| | ↓ Technology concept |
| Funding authority ▸ | ↓ RTD (funding, work, demo) |
| Lawyer ▸ | ↓ IPR protection |
| Business analyst ▸ | ↓ Market intelligence |
| Consultant ▸ | ↓ Tech. implementation plan |
| Broker ▸ | ↓ Technology marketing |
| Broker ▸ | ↓ Partner search |
| | ↓ Negotiations |
| Lawyer, finance ▸ | ↓ TT agreement |
| | 'After sales' support |

*Source:* Help-Forward network

**Table 4(b)** TT process – recipient

| *Technology recipient* | *Other parties involved (recipient side)* |
|---|---|
| Technology audit ↓ | ◂ Technology consultant |
| Technology watch ↓ | ◂ Technology consultant |
| Technology provider search ↓ | ◂ Broker |
| Technology evaluation ↓ | |
| Technology acquisition feasibility ↓ | |
| TT funding ↓ | ◂ Financial institution |
| IPR due diligence ↓ | ◂ Lawyer |
| Negotiations ↓ | |
| TT agreement ↓ | ◂ Lawyer, finance |
| 'After purchase' support | |

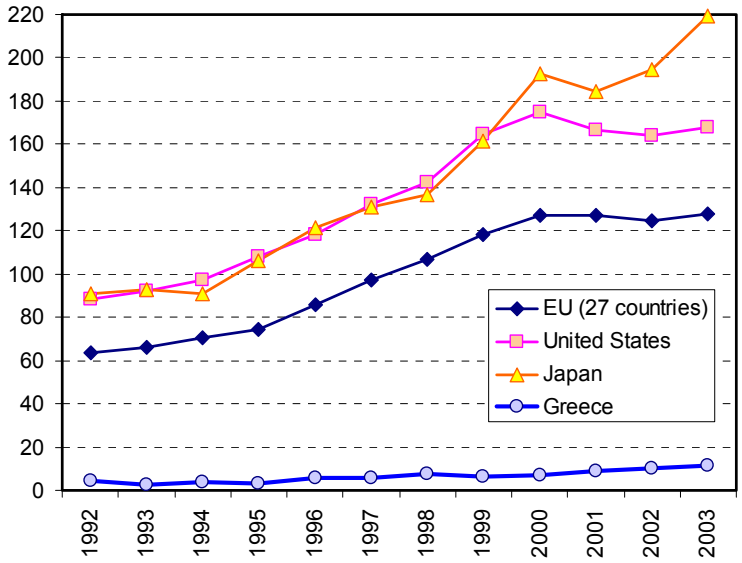
*Source:* Help-Forward network

All above mentioned factors may incur serious obstacles to the successful conclusion of a TT agreement at any market, let alone immature TT markets in which there is poor RTD production, small market size, introvert market character, small businesses striving in micromanagement and day to day topics, lack of social recognition of the researcher, low competition economy, lack of risk-taking culture in business and finance, low production and trade figures.

### *2.2.3 TT market and innovation policies in Greece*

R&D expenditure in Greece is currently 0.61% of GDP, while the EU25 average is 1.85% (see Eurostat, 2008). Another descriptive marker for the maturity of a TT market is patent figures (as an index of intentions to commercialise). European Patent Office (EPO) publishes regularly figures concerning intellectual property rights, which can speak for themselves:

**Figure 1** EPO patents per million of inhabitants (see online version for colours)




*Source:* EPO (2005)

Community support framework has been employed as the key tool for changing this image. Within the last few decades, the research infrastructure has been strengthened and several mechanisms (funding and institution building) have been devised. A breakthrough policy tool, however, has been the spin-off programme launched by the GSRT, Greek Ministry for Development (2004). Seed capital (stage 1) of the programme supported 200 exploratory projects with 9mio €, while spin-off establishment (stage 2) of the programme supported the creation of 36 companies with 22mio €, based on the principle 'match 50% if privately invested 50%'. To the authors' knowledge, 25 firms established at that period are still in operation (see Greek Help-Forward network website at http://www.help-forward.gr).

In 2000, the government established the New Economy Development Fund SA (see for more information TANEO website at http://www.taneo.gr). It is the first and only 'fund of funds' in Greece aiming at the competitive development of venture capital funds oriented towards supporting innovative SMEs. TANEO matches the investment of private funds in new technology-based firms (NTBFs), mobilising the venture capital market in Greece. Together with Invest in Greece Agency (details can be viewed at http://www.investingreece.gov.gr) and Help-Forward network, it organises since 1999, on an annual basis, an international venture capital forum in Greece, a business cooperation (partenariat type) event bringing together investors and entrepreneurs (see *International VC Forum Series in Greece Since 1999*, http://www.vcforum.gr/9th/index.php?q=pastForums).

The above mentioned initiatives have created a new environment in the country, despite the poor performance of the country in RTD, TT and innovation indicators. Some results of these policies (too early to be evaluated) have already started to show.

## 3 Empirical study

### *3.1 Research methodology and data*

In order to explore the development of TTT strategies in an immature TT market and check what applies to Greece's case, we employed a qualitative approach that is a case study method (Yin, 1994). This paper examines cases of TT involving Greek technology providers, identifies qualitative features of success, obstacles and points of weakness, and draws some first conclusions on internationalisation as the key mechanism for the effective commercialisation of research results. The study is semi-empirical and is based on data collected and experience accumulated during the operation of Help-Forward Network as IRC, a member of the European IRC network (IRCnet, 1995–2008). Details on the network can be viewed at the European IRC network website at http://www.innovationrelay.net. The sample used to assess the optimum tools and best practices constitutes of eight cases of TT agreements involving Greek partners, concluded over the last five years.

### *3.2 Spin-off case studies*

#### *3.2.1 Mature success stories (over ten years of operations)*

University/research centre spin-off was not a frequent business development model in Greece until recently. Before the government spin-off programme, only two success stories have been recorded: FORTHnet SA (the first internet company in Greece since 1996) and CBL Patras (a biotech firm, established in 1990). They both have today an established presence in the market (Greek and international accordingly).

*FORTHnet SA* (more than 110mio € turnover in 2007) took advantage of the world internet boost and presented the first privately offered service in the Greek market. Soon, it extended its activities in voice telephony, following the liberalisation of the communications market, while recently, it has moved into the cable/satellite/digital media and television platform market. International private funds were shareholders from the establishment of the company until today.

*CBL Patras SA* was founded in 1990 by a world-leading scientist in solid phase peptide and organic synthesis. It is present in Patras, Greece and Colorado, USA. CBL operates the largest and one of the most advanced plants worldwide for Fmoc solid-phase peptide synthesis. Its capabilities cover all levels and stages – from preclinical to launched products and from milligrams to tons of final products. For two consecutive years in 2001 and 2002, CBL was given the award for the Year's Best Supplier of Raw Materials by F. Hoffmann-La Roche. CBL's production of products is based mainly on the founder's discoveries, including the 'Barlos resin' and it has the exclusive production rights to these products. The company's products are exported to pharmaceutical industries in North America, Europe and Japan, as well as to research university laboratories and institutions in Greece.

#### *3.2.2 Ambitious young spin-offs (operating in the last six years)*

Out of the 25 universities and research centre spin-off companies established in Greece in the last six years, 20 have equity partners that other industrial firms wishing to diversify in a higher technology market, while only five were based on venture capital

(or incubator) support. Without claiming that the following case studies are the most successful commercially ventures, compared to those not presented, it is worth mentioning that they have a strongly international strategy, global approach and extrovert business culture.

*FORTH Photonics SA* is a high-tech medical device company (FORTH spin-off) in biophotonics and optical molecular imaging focusing on the development of automated, cost-effective devices for the non-invasive optical detection, screening and guided therapeutics of cancerous and precancerous lesions. The company has received VC funding at two stages and has developed a multinational structure and strategy: the company has headquarters in Athens, Greece and a UK branch in Edinburg, UK where clinical acceptance and further commercialisation for the company's key product (DySIS imaging system is promoted).

*Nanochronous Logic, Inc.* is a FORTH start-up company with headquarters in San Jose, California and R&D centre in Crete, Greece. They develop design-for-variability, design-for-manufacturability EDA tools for ASIC/SoC circuits implemented in nanoscale standard-cell libraries. The company has on its board managers of international reputation and has chosen to set up its headquarters in the heart of the region that the industry it targets is located.

*BioGenomica SA* is a spin-off company of the National Centre for Scientific Research (NCSR) 'Demokritos' and is a subsidiary of Biomedica Life Sciences SA, one of the leading companies of Greece in the fields of radiopharmaceuticals and imaging instrumentation. It was founded in 2004, provides a wide range of highly specialised services in genetic testing. The services include molecular analysis of disease predisposing genes with applications in oncology (sporadic and hereditary cancer), gynecology, cardiovascular and neurological disorders, and rare diseases as well as genotyping with direct applications in virology and custom-designed genetic profiling. Since 2006, BioGenomica is a scientific and commercial partner of AGENDIA, Amsterdam and a spin-off company of the Netherlands Cancer Institute.

*i-sieve Technologies Ltd.* is a spin-off company of the NCSR 'Demokritos' in Athens. It was founded in the late 2004 by four eminent researchers and has been vested with full IPRs from the research centre and its founders. i-sieve Technologies serve mainly corporate clients and media firms in Europe and the US with business intelligence applications through online media analysis. i-sieve analyses on-the-fly web media, blogs, forums and chat room contents to deliver sentiment snapshots and trend detection insights.

*Biomedcode Hellas SA*, a spin-off company of the Biomedical Sciences Research Center 'Alexander Fleming', has been established with the major goal of providing services to biotechnology and pharmaceutical companies. Biomedcode provides evaluation of therapeutics in unique complex transgenic animal models of human inflammatory and autoimmune diseases, such as rheumatoid arthritis, Crohn's disease, multiple sclerosis, cachexia and other disorders.

*HELBIO SA* is active in the development and commercialisation of hydrogen and energy production systems from renewable sources integrated with fuel cells. The main hydrogen carriers utilised include biofuels such as bioethanol, biogas and bio-oil. HELBIO was established in 2001 as a spin-off company with the purpose to commercialise fuel-processing technology developed at the University of Patras, Greece. The company was funded by venture capital (Emporiki Bank SA). In August 2007,

Swedish Morphic Technologies reached an agreement on the acquisition of a majority share of HELBIO.

*Advanced Energy Technologies (ADVENT) SA* develops new materials and systems, such as fuel cells and photovoltaic systems, for renewable energy sources. The major effort of this start-up company focuses on a prototype high temperature PEM fuel cell system based on ADVENT's proprietary technology. The company, founded by researchers from FORTH and the University of Patras, is a spin-off operation from these two academic institutions and is funded by industrial partners (Germanos SA, Velti SA, Ilpra SA), private investors and the Greek Ministry of Development ADVENT Technologies is headquartered in Athens and occupies development space at the Patras Science Park (PSP) and in its US location in Boston, Massachusetts.

**Table 5** GR spin-off firms' internationalisation features

| *Company (established)* | *Presence with premises abroad* | *International sales* | *International strategic partners* |
|---|---|---|---|
| FORTHnet | | | Yes |
| CBL Patras | Yes | Mainly | Yes |
| FORTH Photonics | Yes | Mainly | |
| Nanochronous Logic | Yes | Target | |
| BioGenomica | | | Yes |
| BiomedCode Hellas | | Mainly | |
| HELBIO | | Yes | Yes |
| ADVENT | Yes | Mainly | |
| i-sieve | | Mainly | |

*Source:* Help-Forward network, processed data

## 4 Discussion of research findings

### *4.1 NTBFs and their impact*

*NTBFs*, particularly, in immature TT markets, can play a very significant role:

- they provide employment for highly qualified personnel
- they infuse innovation spirit in the local society
- they can introduce new products and services
- they strengthen the export potential
- they contribute to the competitiveness of local economies, by introducing knowledge base products and services of added value, especially in countries where production and labour costs are not low (any more).

### *4.2 Technology-based spin-offs*

'NTBF are usually university and research centre spin-offs'. These institutions may decide to license, sell IPRs, provide research and technology services or (under certain

conditions) may decide to commercialise their know-how by establishing spin-off companies.

To do so, the key technology they offer should not be 'burnt out' just for one-off products or services, but should provide the platform for long-term, versatile products and applications. The researchers involved must have a long-term commitment to the business and willingness to dedicate themselves to the new company and their expectations for reward (for both the researchers and their institutions) must be high. Legislation and regulation in the institution must exist so as to encourage going out to the market, rather than staying in the lab and the classroom.

The obstacles mentioned in Section 2.2.2 could be even higher in the case of a spin-off, especially at the start-up stage, where the seed capital from the university/research institution is not frequently available. It is this point where innovation policies and tools are highly needed.

Professional support at the stages of IPR protection (patent attorneys), market intelligence (business analysts), business planning (business consultants), technology marketing and business partner search (brokers and marketing experts) and finally during negotiations with potential business partners and investors, is absolutely vital.

In immature TT markets like Greece, one can meet the following conditions:

- highly qualified RTD personnel and pockets of excellence in research (RTOs with international reputation)
- recognised Greek scientists abroad willing to make a come back if they find a suitable environment
- research teams 'addicted' to R&D proposal chasing, project running and article publishing, within the academic environment
- research groups with international reputation, working with foreign industries, rather than Greek ones, as the latter ones lack RTD and innovation culture
- small and family-run traditional industries, unable to diversify or visualise opportunities stemming from RTD work and its results
- investors acting more like old-style bankers, taking no risk and looking down upon any venture related to S&T (topics they do not feel comfortable with…).

### *4.3 Internationalisation strategy*

The spin-off companies established in the last few years in Greece indicate the way towards the steps and initiatives that have to be taken in order to cope with the immature market inertia. It must be noted that most of the identified spin-offs have made good use of the government policy initiative (spin-off) and approached established industrial firms mainly as their business partners in the new venture.

What, however, is common in most of the case studies aforementioned is the internationalisation aspect of most ventures. Some of them chose to have premises abroad, so as to target better the global market. Some others selected to have international partners as shareholders, so as to gain from their experience and position. In all cases, international sales are the key strategy of technology-based spin-off firms established in Greece in the last six years.

Nevertheless, internationalisation is not only the recipe for spin-off success. FORTHnet SA, the first internet provider in Greece, attracted foreign investment, not for selling abroad, but for bringing a new revolutionary technology in the Greek market. They were simply ready at the right time when internet technology was conquering the world – and they had the local demand to satisfy. The effect and value of the spin-off 'experiment' in the Greek market will be assessable in a few years time. In the meanwhile, an in-depth analysis of all parameters of operation (from conception, to birth and growth – or even bankruptcy) of spin-off firms would be valuable. Parallel assessment of the measures and financial instruments that contributed to spinning off (or failed to) will also be useful from the policy point of view. In the meanwhile, some first conclusions can be drawn and suggestions are made.

## 5 Concluding remarks and ways forward

University and RTO spin-offs have started to sprout in European and Greek institutions in the last 15 years, following the US trend set in the early '80s. Legislative initiatives have allowed the use of publicly funded RTD results in commercial ventures. Best practices have been identified by the EC (European Commission, 2002b) and recommendations have been made, mainly towards the Member States concerning policies and mechanisms that can be designed to further facilitate the commercialisation of research results.

Beyond the policy stage and the effectiveness of the tools and legislation in encouraging universities and researchers to spin-out, the experience drawn from the first initiatives in Greece has shown needs (to facilitate the establishment) and tips (to pave the success) for spinning-off. According to the European Commission (2008b), expecting the state on its own to initiate business activity in the RTD world could only widen the innovation gap between Europe in one side and US and Japan in the other (European Commission, 2008a).

*Academics* should accept that R&D should have direct economic as well as scientific impact.

*Researchers and their institutions* should protect their IPRs more seriously (and spend some money on it).

*Venture capital firms and investors* should realise that several of nowadays commodities were considered by the people and most businesses of the last century as nonsense (car, photocopier, telephone and television).

*Specialised business advice* is vital. A researcher cannot develop, manage people, detect market trends and sell products at the same time on his/her own.

New entrepreneurs should take into account that local markets are too small for RTD products and services. 'The way out is internationalisation'. The latter has been the key finding of the empirical study presented in this paper. Several of the new spin-off firms in Greece have decided to 'go international'. Internationalisation of activities does not only imply aiming sales abroad (they have to). It means invitation of foreign capital and know-how into the business, physical company presence abroad, strategic partnerships and agreements with key foreign players. It requires a coherent global strategy of growth.

## 6 Limitations and future research

This research has important implications for understanding better how to build up effective TT mechanisms and achieve successful TTT agreements in immature TT markets such as Greece. It also offers valuable empirical evidence and insights on the internationalisation aspect involved in the dynamic of the TT process. However, as all studies, it has limitations. The sample of the case studies used in this paper is limited, given the very small number of Greek universities' spin-outs available at present and the short time since legislative initiatives, which allowed the use of publicly funded RTD results in commercial ventures, have come into force (just in 2002). The eight cases described and analysed in the paper have been selected on no-criteria basis since they were the only ones available. The findings may be influenced by their specific characteristics and consequently, conclusions cannot be generalised statistically. Future research could extend our work either by using a larger sample and identifying further factors that deliver better in technology development and TTT agreements in Greece or by examining cases in other immature TT markets.

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## Notes

1 The 'European paradox', as popularised by the first 'European report on science and technology indicators' (European Commission, 1994), refers to the fact that Europe plays a leading world role in terms of scientific excellence and the provision of highly skilled human capital. But it largely fails to convert science-based findings and inventions into wealth-generating innovations.

2 The Lisbon European Council of 2000 introduced the Lisbon mandate, which outlined guidelines for supremacy by 2010 in the fields of knowledge and technology along with growth and jobs. The indexes that account for the Lisbon agenda are seven: GNP (measured in consumer power), labour productivity, employment (%) in age brackets 16–64 and 55–64, investments in R&D as proportion (%) of the GDP, intra-regional deviations in the unemployment rate, and long-term unemployment as proportion (%) of the total work force.