Building support infrastructure for technology-based businesses: What emerging economies can learn from the Western experience?

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1. Introduction

Increasingly, new technology-based firms are viewed as a source of economic development playing a key role in enhancing entrepreneurship (Siegel et al., 2003b). They provide the foundation for development of new industries and of regional hi-tech clusters (Autio & Yli-Renko, 1998; Birley, 2002; Bray & Lee, 2000; Venkataraman, 2004). In the heart of concept of support infrastructure for new technology-based businesses are the university based business incubators and science parks. At the point of their origin, university based incubators and science parks were viewed as a mechanism of linking talent, technology, capital, know-how to leverage entrepreneurial talent, accelerate the development of new technology-based firms and speed the commercialisation of technology (Z. A. Mian, 1997). The issue of fostering innovation through better technology transfer and formation of high potential ventures is acute for many countries. For Central and East European countries, including Russia, this issue has a greater significance since these countries have to improve their performance by accelerating rates of economic growth. In this respect, building support infrastructure for technology-based businesses is a natural and logical way of developing fast growing entrepreneurial economies. However in recent years the effectiveness of business incubators and technology parks is questioned both by academics and practitioners. Studies suggest that an incubator or science park location does not contribute to a firm's economic performance (Lofsten & Lindelof, 2002, 2003; Oakey & Mukhtar, 1999; Westhead & Storey, 1995). To be successful technology parks and incubators should be more needs oriented both at point of offering and delivery.

Furthermore, support to firms has to be tailored to the specific challenges of the different stages of a firm's lifecycle (McAdam & McAdam, 2008). Oakey and Mukhtar (1999) suggested that the problem with science parks and incubators lies in putting too much effort into creating the physical infrastructure and neglecting the real needs of high-tech firms such as capital, human resources and local networking. Therefore it is important for emerging economies to assess the experience of developed countries and be aware of a danger of a direct policy transplant without consideration of local business environment.

This paper aims to examine the effects of physical infrastructure including incubators and science parks on level of innovation activity and performance of new technology-based firms. It reviews evidence from Western countries comparing various assessment of the impact of science parks on the firms. Next the paper examines the development of science park movement in Russia. Then it explores the empirical evidence from a case-study university in attempt to analyse the shortcomings in present state of the support infrastructure in Russian from point of view of the technology-based companies.

2. Assessment of effectiveness of Science Parks – a review of evidence from the West

The origin of first university based science parks goes back to early 1970s (Siegel et al., 2003b). The modern science parks are designed to fulfil three fundamental functions. They are developed to (a) foster the formation and growth of new technology-based firms, (b) enhance cooperation between large companies and small innovative firms and (c) promote knowledge transfer between universities, research centres and new technology-based firms. Science parks are viewed as a mechanism of linking talent, technology, capital, know-how to leverage entrepreneurial talent, accelerate the development of new technology-based firms and speed the commercialisation of technology (Z. A. Mian, 1997). Therefore the key role of science parks is to fill the gap in critical resources such as human and physical capital.

Body of knowledge on science parks and business incubators has developed significantly since the early 1980s. The existing literature is debating the role of science parks and incubators as points of accessibility to various resources for new firms, such as technology links, research collaborations, human resources (Quintas et al., 1992; Siegel et al., 2003a; Vedovello, 1997) as well as the effect of science parks and incubator location on economic performance of their tenants (Lindelof & Lofsten, 2002; Lofsten & Lindelof, 2002, 2003, 2005; S. A. Mian, 1996; Z. A. Mian, 1997; Westhead & Storey, 1995). Hansson *et al* (2005) stresses that it is difficult to assess the impact and effectiveness of science parks due to the diversity of objectives and expectations of all involved parties (university, government, private sector, tenants).

Nonetheless, several parameters of effectiveness of science parks and business incubators are address in the literature. Firstly, analysing the experience of the UK science parks in terms of generation of new university firms, Quintas *et al.* (1992) found that although the occurrence of spin-off firms varied considerably across science parks, on average it did not exceed 25% of all firms located in the science parks. Similarly, in case of US universities, Di Gregorio and Shane (Di Gregorio & Shane, 2003) found little evidence that university incubator and venture capital programmes have a positive effect on the rate of formation of new technology-based firms. Secondly, in terms of performance recent studies suggest that incubator or science park location does not contribute to a firm's economic performance (Lofsten & Lindelof, 2002, 2003; Oakey & Mukhtar, 1999; Westhead & Storey, 1995). Furthermore, Quintas *et al* (1992) noted that firms located in science parks did not perform well in comparison to other companies. Westhead and Storey (1995), and Lofsten and Lindelof (Lofsten & Lindelof, 2003, 2005), linked the differences in economic performance to such factors as motivation of founders, cooperation, and networking opportunities within universities. Heydebreck *et al.*(2000), in its assessment of effectiveness of innovation support, concluded that the services should be more needs oriented both at point of offering and delivery and, most importantly, transparent and accessible. Furthermore, the support to firms has to be tailored to the specific challenges of the different stages of a firm's lifecycle (McAdam & McAdam, 2008). In his approach in assessing the

effectiveness of university based incubators, Mian (1997) proposed to include the perceived added value of services provided both by an incubator and a university. Oakey and Mukhtar (1999) suggested that the problem with science parks and incubators lies in putting too much effort into creating the physical infrastructure and neglecting the real needs of high-tech firms such as capital, human resources and a local network. This account is supported by a study by Meyer (2003), which revealed that fast growing spin-off companies were found in university based incubators with experienced board and supervisory board members providing necessary managerial support to the firms.

Establishing university-industry links and building innovation networks are another assumption behind the concept of university based incubators and science parks. The studies indicate that companies located on science parks rarely develop *formal* links with universities and/or incubators and science parks (Oakey & Mukhtar, 1999; Vedovello, 1997). Nonetheless, the geographical proximity of an incubator and science park location facilitates *informal* links though human interaction between firms and universities (Vedovello, 1997). Rotharemel and Thursby (2005a, 2005b) researched the ties between firms and universities; they found that faculty involvement reduces the likelihood of failure because it facilitates the transfer of tacit knowledge.

The evidence from Western literature shows that the concept of science parks, based on a linear model of the relationship between science and innovation and a role of science parks as providers of physical infrastructure may need to be replaced by an interactive, dynamic and network-oriented understanding that emphasises learning instead of a narrow understanding of scientific innovation and regional development (Hansson et al., 2005).

3. Development of support infrastructure for NTBF in Russia

Following the switch to the market economy, government policy envisaged putting R&D onto a commercial footing, so that state funding could be replaced with private funding. The

commercialisation of research has, however, not fulfilled expectations due to underdeveloped state of institutional infrastructure of the Russian economy (Radosevic & Myrzakhmet)and to the ingrained tendency to emphasise the high technological level of products without properly investigating the demand for them (Kihlgren, 2003). The creation of science parks has been one of the few measures adopted in order to favour this transformation.

The creation of science parks has been one of the few measures implemented to favour the commercialisation of scientific research. In Russia the concept of science park was introduced in 1988. The first science park was established in Tomsk in 1990 jointly by universities, scientific institutions and industrial enterprises. In Russia most of the science parks have been set up under the state programme “Technology Parks and Innovations”, which aims to promote the scientific potential of universities. The number of Russian science parks created in the framework of this programme was fifty-two out of a total of sixty-two, in January 1996 and the number of small firms based in these structures more than 1000 (Shukshinov & Tabachenko). The initial stage of the development of the support infrastructure including science parks (the term science park includes in the Russian context both technology parks and innovation centres) was somewhat sporadic without clear understanding of the nature of technology-based entrepreneurship, its needs and ways to satisfy them. Most of them are non-profit-making organisations which, according to their statute, must reinvest any profits to develop their infrastructure and services for tenant companies, but their financial situation is not easy given the low demand for technology-based products in Russia and the difficulties in attracting private investors. According to Kihlgen (2003), an unusual feature of Russian science parks is that the vast majority of them have originated from universities, despite the fact that universities accounted for only 6% of R&D personnel in the Soviet Union, while branch research institutes, where the bulk of R&D personnel was concentrated, have participated very little. This is because the latter suffered much more from the disintegration of the command system (Kihlgren, 2003). Another specific of Russian science parks is that not all firms are accommodated on site due to space limitations. Some are located in the nearby university or in

other institutions linked to the technology park. In Russia technology parks are usually dependent on other institutions, mainly universities. As a rule, the university provides the building and finances most of its current expenses, while the state usually finances the purchase of some equipment and the reconstruction of the building..

At present the development of the technology parks became a more organised process. In the end of 2008 a new decree, "On the procedure of the federal budget provided for the establishment of technology parks in the sphere of high technologies" was adopted by the Russian government allocating over 26bn RUR (~ £500 m) to building seven technology parks in Russia (Malakhov, 2006). The government estimate that by 2011, companies located in technoparks will generate 117 bn RUR (~ £ 2.3 bn) in product and services (C.News, 2007). This looks to offer a promising future for the development of small technology-based firms. However, the policy failed to address the issue of the formation of new technology-based firms. There is no stimulus for small businesses to engage with R&D organisations to commercialise the research results. The formation of spin-off firms still has an accidental nature. The big question is where the tenants of new technoparks will come from? Promoting formation of new technology-based businesses should be at the forefront of policies on both a national and regional level.

4. Methodology

As pointed above one of specific feature of Russian science parks is it's close proximity to the universities and a fact that many of the tenants firms might be located at university premises. Therefore, the focus of this paper was university spin-off firms which represent a sub-set of technology-based firms. An embedded case design(Yin, 2003) was adopted as a research strategy for this paper. In Russia, the university spin-off process is a relatively new and rare occurrence. Very few universities have a clear understanding and support of the process. The primary challenge was to choose case-study University. The decision was made to select

university (1) outside of Moscow as it could bring a bias of capital city location; (2) advanced in spin-off activities both in terms of existence of spin-off firms and developed elements of support infrastructure. As a result the Ural State Technical University has been chosen which has developed a support infrastructure and encountered a sufficient number of spin-off companies.

The data collection has been split in two stages. During the first stage, the key players in spinoff process have been interviewed across the university, as well as representatives of federal and local government, financial institutions, members of business associations, etc. A set of in-depth interviews with founders of the university spin-off companies has been conducted to identify the needs and problems of the university spin-off firms.

The second stage was collecting data from the university spin-off firms. Despite the claim of nearly hundred technology-based spin-off firms, there was no any formal information available about those firms. That is why an initial aim was to identify population of spin-off companies by exploiting all available sources of information. According to different sources, the university encountered forty-two university spin-off firms, however, the contact details of only thirty-three companies were identified and these companies were approached, four of them refused to participate in the questionnaire survey, thus data were obtain from twenty-nine companies. Tables 4-7 present the basic characteristics of the firms in the sample such as their age and size in terms number of employees and turnover as well as targeted markets.

Based on the results of the first stage of the project, a questionnaire has been developed. The questionnaire covered a wide range of issues of the university spin-off process. A separate part of the questionnaire was dedicated to researching founders' characteristics such as past and current position at the university, perception of a firm's growth potential and plan for the future, initial motivation to set up a business, prior management experience.

Obtained data has been processed and analysed using descriptive analysis tools. The results drawn from the questionnaire survey were complemented / contrasted with qualitative data

obtained from the interviewing process on the initial stage of the research. The triangulation of sources of the data provides degree of validity and rigour to the research results.

5. Results and discussion

5.1 The University

The Ural universities play the most important role in the integration of science and industry. One of the leading technical higher education establishments in the Ural region is the Ural State Technical University (former the Ural Politechnical Institute) established in 1927. The University is famous for its contribution to innovation activities in the past, during the Soviet era, when it served to the interests of regional industries. Nowadays, the University commits to the tradition of innovation and keeps pioneering in area of technology transfer and commercialisation. While public policy only recently has acknowledged a necessity to fully exploit available scientific and technical potential to give a new dimension to economic growth, the Ural State Technical University has accumulated nearly 10 years of such experience.

A long history of science and industry integration helped the University to accept the reality of the market economy. When faced with the challenge of social and economic reforms, the University was one of the first institutions to recognise the potential of managing innovations within its environment. In 1990, the University became a leading institute in Russia's first Programme on innovation in science and engineering, launched by the State Committee on Science and Higher Education, "Small-batch and light technology-based production". For the first time in the University's history, the task was to achieve tangible results in a very short period of time (i.e. not more than three years) – to develop new devices, materials, equipment; to implement technology; to market and sell produced output; to gain profit; to create a support fund for financing new technology-based projects. As a result, during 1988-1995 the foundation

for a new infrastructure for innovation support was laid; and a process for the creation of new technology-based small businesses began.

Development of small technology-based businesses within the University called for creating organisation providing the complex of services for small firms. The University administration convinced that for the last decade the University has accumulated experience in support new technology-based entrepreneurship and created a core of innovation complex including basic modules of innovation support infrastructure, namely financial support, information support, personnel training, and incubating new firms. According to the University administration, only during first two-three years about hundred new technology-based firms have been formed by members of the University staff.

Effectiveness of support infrastructure

As mentioned above, the creation of new technology-based companies has been accompanied by a developing infrastructure to support innovations and technology transfer. Prof. Kortov, outlined:

“The University's objective from the beginning was to support research teams in the development of new technologies/products and start new technology-based companies”.

The University administration recognised the necessity of creating a core infrastructure to support new technology-based firms, including financial support, marketing, management and information support, training and incubating new companies. The University’s response was the creation of the first association of the University spin-offs - “Concern UPI-21”. The initial mission of the Concern was fostering small technology-based business through involvement of the University scientists, as well as providing information and marketing support, looking and applying for funding, and negotiating rental agreements for University spin-off companies.

The policy of the Concern encouraged a high survival rate of the small businesses. In 1998, the Concern was self-dissolved as it had accomplished its mission. This gave way to new technology-based support for companies.

By the late 1990s, the University had accumulated experience in the support of new technology-based entrepreneurship and created a core innovation complex - including basic modules of innovation support infrastructure, namely financial support, information support, personnel training and the incubation of new businesses. The development of the existing infrastructure began in early 1990s with participation of the University in a number of the Federal programmes of the Ministry of Education. Later the University and organisation of support infrastructure got involved in a number of international projects which contributed significantly to the enhancement and the development of the whole support infrastructure. Table 1 represents a timeline of the international projects and their impact on the development of the support infrastructure.

Table 1 International Projects and their oucomes for the USTU

Period	Project/ Partner	Project Budget, $	Activities	Outcomes
1995 - 1996	American Small Business Support Centre	30,000	Training for CIB employees in USAID programmes; Financial support to set-up an office.	It lays the foundation for dynamic development of the CIB according to international requirements to organisations of technical entrepreneurship support.
1998 - 1999	Eurasia Foundation .	20,000	Training and business consulting for technology-based firms on business planning, marketing, managing IP, quality management, finance.	100 hours of workshops 400 hours of consulting sessions for companies in cities and towns of the Region.
1999 - present	ISTC	40,000	Training for leaders of R&D projects on technology commercialisation, project management, internet marketing, development of communication skills Support in technologies commercialisation for promising projects (from idea to joint venture).	Regional Educational Centre of ISTC has been set-up for organising regular workshops (about 500 R&D team leaders and managers went through the training) 9 business-plans has been developed 12 R&D projects have received informational and marketing support.

Period	Project/ Partner	Project Budget, $	Activities	Outcomes
2001 - 2002	Eurasia Foundation "	32,000	Developing and probing an alternative to bank short loan scheme to finance technology-based firms, namely a bill of exchange scheme.	13 technology-based companies have received bills of exchange (totally for $25,000).

At present, the University has a unique higher education institute structure - the senior pro-vice-chancellor is in charge of innovation activities at the University. In 2003, “The Institute of Innovation and Marketing was created. The mission of the Institute is threefold: education, policy development and support for technology-based businesses. At an educational level, the Institute provides education and further training in the area of innovation management. For policy development, the objective of the Institute is to provide recommendations on the development of the University's education-research-innovation complex. The Institute provides cooperation with regional government, lobbying the University interests in Federal and local government with regard to innovation activities. At the support level, the Institute provides patenting services, finding investors and advice on technology commercialisation. The Institute co-ordinates and oversees the activities of other support organisations operating under the University umbrella, such as the Centre for Innovative Business (CIB), technological park “Uralsky”, venture fund “Progress”, and the Technology Transfer Office as well as University spin-off companies. From a commercial point of view, the Institute has a target to generate up to 50% of the University income from innovation activities. Schematically, the infrastructure of management and support of innovative activities is presented in Figure 4.

According to this setting, the University has all the elements which create a support infrastructure: combining affords of the Centre of IPR and TTO to promote University-industry cooperation; Foundation “Progress” was set up to provide seed funds for technology-based firms; Technopark “Uralsky” – incubating small businesses; Centre for Innovative Business – consulting and information support for both aspiring and existing companies.

The specific of this structure is that although the support infrastructure exists under the umbrella of the University and their activities are overseen by the Director of the Institute for Innovation and Marketing, they are all independent legal non-profit entities.

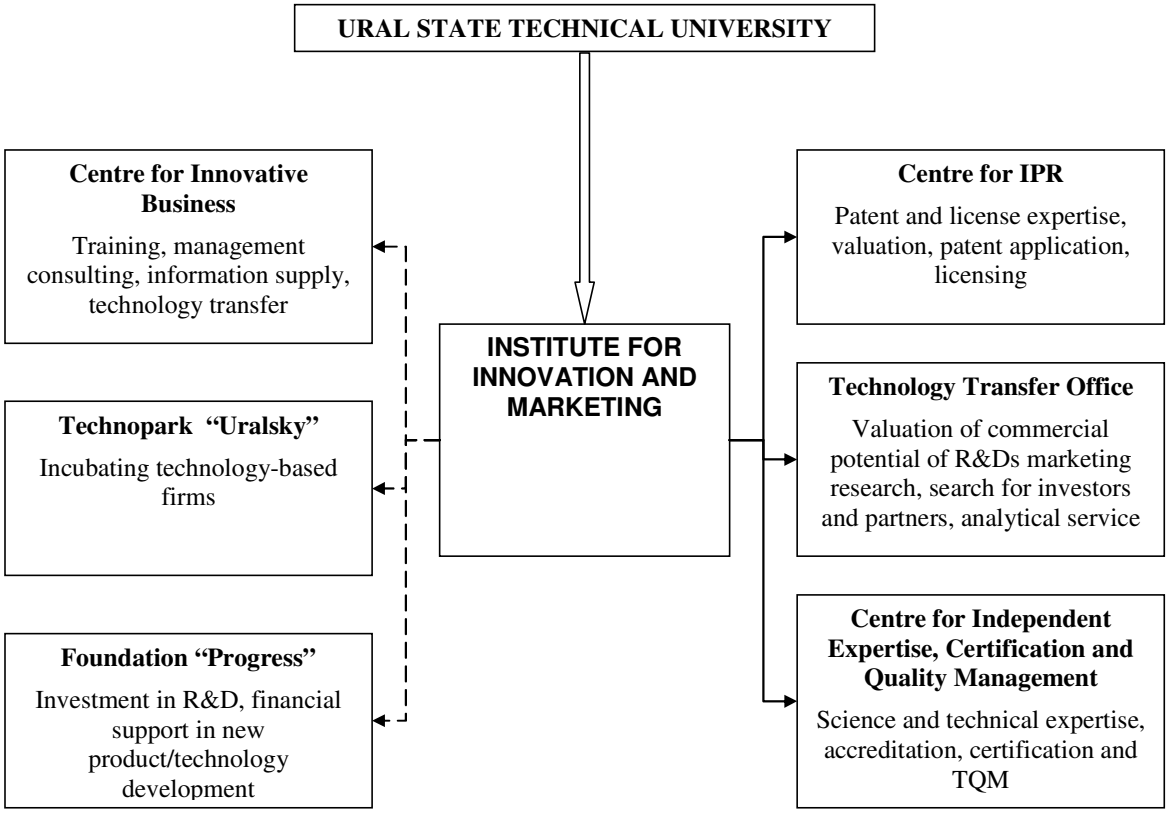

Figure 1 Structure of management and support of innovation activities at USTU

New spin-off companies can rely on consulting support, assistance in grant/bidding applications, representation at trade shows and fairs, developing business plans and investment proposals. Through its supportive infrastructure, the University offers short-term training on business, management and negotiation skills. Some of these services are free of charge (where they are supported by grants) or offered with significant discounts.

Does this structure prove successful? The survey of the University spin-off companies indicates that only a very small proportion of companies are actually aware of the existence of the support organisation at the University. Table 2 represents the results.

Table 2 Spin-off companies awareness of the existence of support organisations

		Year of foundation		
		1989 - 1993	*1994 - 1996*	*1997 - 1998*
		%	*%*	*%*
Centre for Innovative Business	Unaware	66.7	50.0	100.0
	Aware	33.3	50.0	0.0
Centre for Intellectual Property	Unaware	52.4	50.0	50.0
	Aware	47.6	50.0	50.0
Technopark “Uralsky”	Unaware	42.9	33.3	50.0
	Aware	57.1	66.7	50.0
Centre for Certification	Unaware	57.1	83.3	50.0
	Aware	42.9	16.7	50.0
Foundation "Progress"	Unaware	71.4	66.7	100.0
	Aware	28.6	33.3	0.0

The most “popular” organisation is the Centre for Independent Expertise, Certification and Quality Management (CIECQM). The Centre scored the highest rating among surveyed companies (see Table 3). The reason for this is the issues concerning state regulation and bureaucracy. According to the Federal regulation, all companies must have a so-called quality certificate for the products they sell. For existing products, the issue is easily resolved – the products are tested for compliance with existing standards. However, according to the technical entrepreneurs, the problems arise with new products. In fact, the issues with state regulation and bureaucracy achieved the highest score, even exceeding financial problems. According to the interviewees, the new products do not have standards or benchmarks to test against. No standards in place means no quality certificate is issued - and with no quality certificate, a company cannot sell its product.

The objective of the CIECQM is to help firms to overcome this problem. In short, the Centre solves very particular and practical problems that are commonplace for the majority of technology-based companies.

Table 3 Evaluation of the effectiveness of support organisations

	Mean	*Std. Deviation*
Centre for Innovative Business	3.3	1.57
Centre for Intellectual Property	2.8	1.19
Centre for Certification	4.2	1.00
Technopark	3.4	1.43
UPI 21*	3.6	1.77
Foundation “Progress”	3.4	1.27

* Existed until 1997

The least popular is the Centre for Intellectual Property. Indirectly, it confirms the above mentioned statements regarding disrespect to IPR at the University from academics. Informal comments from spin-off companies were that these organisations (except CIECQM) were created to extract money from the spin-offs and the services that they are providing do not address the needs of the companies. It should also be mentioned that spin-off companies highly regard their own managerial competencies and do not believe that management skills training, for example, would be beneficial for their business managers. In general, the demand from the spin-off companies is result oriented. It is very much a “here and now” mentality, without consideration for the future of the business.

6. Conclusions

Over a period of ten years, the University has built up the infrastructure to address the needs of the emerging companies, as well as introducing formalised policies regarding intellectual property rights, equity sharing and use of University resources. The paper assessed the impact

of the support infrastructure on resolving problems and overcoming obstacles by the University spin-off companies. It is without doubt that the University's attempts to develop a supportive infrastructure were aimed at fostering commercial activities within the institution. However, the perception of its effectiveness among spin-off companies is extremely low. The paper has shed light on the issue of communicating the University policy to a wide audience within the University. It has emphasised that to increase the level of innovation activities and spin-off processes in general, the University needs to improve communication with new and existing spin-off companies, listen to their demands and incorporate their expectations into the overall strategy. The aspiring and established entrepreneurs must be aware of University policy and procedures and of the consequences for breaching the agreements.

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TABLES

Table 4
Year of foundation of spin-off firms

Year of foundation	*Number*	*Percentage*
1989 - 1993	18	72.00%
1994 - 1996	5	20.00%
1997 - 1998	2	8.00%
1999 – present	-	0%

Table 5
Size of the spin-off firms (employees)

Number of employees	*Full-time*		*Part-time*	
	No	*%*	*No*	*%*
1 - 9	18	75.00%	8	38.10%
10 - 19	2	8.30%	6	28.60%
20 - 49	3	12.50%	3	14.30%
50 - 99	1	4.20%	2	9.50%
Over 100	-	-	2	9.50%

Table 6
Size of the spin-off firms (turnover)

Annual turnover		*Number of firms*	*%*
1,000 RUR	*£*		
<1,000	< 20,000	9	36.00%
1,000 - 9,999	20,000 – 199,999	12	48.00%
10,000 - 49,999	200,000 – 999,999	4	16.00%
50,000 +	Over 1,000,000	-	-

Table 7
Targeted markets of the spin-off companies

	Number	*Percentage*
Local Market	19	79.31
Domestic Market	15	58.62

	Number	***Percentage***
International Market	3	10.34