Ukraine's Potential for innovation and Its Realization through International Scientific and Technical Cooperation*

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ABSTRACT. This paper uses quantitative and qualitative measurements to assess comprehensive Ukraine's current potential for innovation. It argues that innovation plays a critical role in fostering the country's economic growth under conditions where social products are being intensively reproduced and are raising the country's competitive strength on the international arena. It reveals the peculiarities and major trends of innovation in Ukraine, as well as some yet undeveloped opportunities and presents ways to promote such activities in the context of international scientific and technical cooperation. It emphasises the need to diversify the format of international cooperation via the development of venture business, the creation of techno-cities and techno-parks, the formation of joint venture enterprises, and the execution of scientific projects and programs with certain international partners, primarily Russia and countries of the European Union.

KEY WORDS. Innovation, innovation potential, innovation product, innovation infrastructure, international scientific and technical cooperation, venture capital, venture companies, techno-cities, techno-parks.

Introduction

Under the prevailing conditions of a nascent global economic system based on post-industrial principles, the economic growth of individual countries and their international competitive abilities are determined in a decisive manner by the intellectualization of principal production factors and by the availability of a potent innovation potential. This potential is understood as the sum-total of intellectual, technological, and research-and-production resources complete with the appropriate infrastructural support, the capability to gen-

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erate new knowledge, plus the efficient machinery for the commercialization thereof. The importance of the innovation factor for economic development is corroborated, in particular, by the fact that in developed countries the specific weight of new knowledge in commodities, technologies, education and organization of production accounts for 70 to 85 percent of GDP.[1]

Ukraine's strategic priority in the context of assuring national competitive strength within a post-industrial economic system consists of mastering the scientific-technological model of economic development. The basis for achieving this priority is the presence of its own internationally recognized schools of scientific thought, as well as its unique technologies in the fields of new materials development, biology, radio electronics, low temperature physics, electric welding, informatics, telecommunications, and military technologies, which provide the capability of developing hi-tech production on a par with the highest international standards.

Furthermore, Ukraine possesses a strong legacy for the dynamic advancement of the most up-to-date trends in fundamental and applied sciences established at different points in history by such world-famous scientists as I. Puliuy, A. Aleksandrov, M. Boholiubov (physics); M. Kravchuk, V. Hlushkov, M. Grave (mathematics andcybernetics); M. Tuhan-Baranovskiy, S. Kuznets, P. Ptukha (economics); I. Sikorsky, Yu. Kondratiuk, O. Antonov, S. Koroliov, M. Yanghel, M. Duhov, Ye. Paton, B. Paton (technologies); and I. Mechnikov, O. Palladin, O. Bohomolets, V. Filatov, M. Amosov and V. Vernadskiy (medical science and biology), to name a few.

The Development and Current Status of Ukraine's Innovation Potential

Ukraine's current innovation potential developed during the second half of the twentieth century during the revolution in universal scientific-technologies and is characterized by its relatively high quality. As part of the integrated economic complex of the former USSR, Ukraine's potential was significant. Thus, according to the United Nations Education, Scientific and Cultural Organization (UNESCO), Ukraine's share of the world's overall engineering and scientific potential amounted to almost 7 percent at the time. Al-

[1] Leonid Kuchma, *Utverdzhuvaty innovitsiynu model' rozvytku ekonomiky Ukrainy*, Vystup Prezidenta Ukrainy L. D. Kuchmy na naukovo-praktychniy konferentsii, 21 lyutoho 2003 r. (Kyiv: Presa Ukrainy, 2003), s. 13 [Leonid Kuchma, *Implementing the Innovation Model for the Development of Ukrainian Economy*, speech to an academic-practical conference by the President of Ukraine, L. D. Kuchma, 21 February 2003 (Kyiv: Press of Ukraine, 2003), p. 13].

though representing just 2.7 percent of the Soviet Union's territory and 18 percent of its population, Ukraine at the same time was involved substantially in international cooperation in research and development, not to mention that it had a prominent role in the inter-republican division of labor with its share in scientific and technological production amounting to approximately 40 percent and its share of the USSR's GDP being close to 20 percent. For example, in 1988 in the USSR Ukraine mined 25 percent of its coal, smelted 35 percent of its steel and 41 percent of its iron, extracted 46 percent of its iron ore, manufactured 23 percent of its tractors, 37.1 percent of its color TVs and 96 percent of its diesel locomotives[2].

At the same time, Ukraine's involvement in the universal scientific and technological progress was not limited to the highly diversified structure of the national economy, but was also characterized by the presence of frontline (even by international standards) scientific and education facilities. Thus, research in Ukraine was carried out in or by 1,900 scientific research establishments, organizations, and enterprises employing a total of about 500,000 scientists and other related personnel, including nearly 6,500 doctors of sciences and 150,000 candidates of sciences, representing 5.4 percent of all able-bodied citizens of the country compared to 6.4 percent in the United States [3]. Ukraine had many achievements in the development of such fields of fundamental science as mathematics, solid state physics, physico-chemical fundamentals of metallurgy, physiology, cellular engineering etc.

However, since the late 1980s when the Soviet economy was close to being paralyzed, the demand for scientific products sharply decreased. Thus, close to 108,900 inventions were not implemented, despite over 80 percent of them having been made and registered between 1985 and 1990. Combined with an advanced physical (60 percent) and moral depreciation of fixed capital stock (almost 90 percent), this led to the loss of competitiveness in the country's industrial output in external markets.

During the 1990s and the deep economic crisis that prevailed, the scientific-technological potential of Ukraine continued to deteriorate and the number of design and research institutions and scientists decreased by half. Moreover the contribution of scientific research and experimental development to the country's GDP reached a catastrophic level of 0.3 percent compared to the previous level of 3 percent[4]. By

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[2] *Ekonomichna entsyklopediya: u tr'okh tomakh, Tom 2,* S. V. Mocherny (vidpovidal'ny redaktor) ta in. (Kyiv: Akademiya, 2001), s. 183 [*Economic Encyclopedia: In Three Volumes, Vol. 2,* principal editor, S. V. Mocherny, et al. (Kyiv: Akademia, 2001), p. 183].

[3] Ibid., p. 184.

[4] Calculations based on data from *Statystychnyy shchorichnyk Ukrainy za 2002 rik* (Kyiv: Tekhnika, 2003) [*2002 Statistical Yearbook of Ukraine* (Kyiv: Tekhnika, 2003)]. Scientific funding at less than one percent deprives a country of the chance to develop.

this time as well, scientific equipment had not been replaced for many years, the prestige of scientists became seriously undermined (for instance, with university professors earning in 2000 two or three times less than railway or subway workers compared with the previous period and other countries), fixed capital stock physically depreciated by 70 percent and morally by 95 percent, which caused Ukraine to slip further away from any scientific-technological and social-economic progress. International analysts affirmed this decline, in particular in the World Bank's 1996 survey, «On Human Development in Ukraine,» which first established Ukraine's slippage from the category of countries with an elevated index of human development to the so-called «middle class» [5]. In 1998 the World Bank classified Ukraine as on the verge of being among «poverty-stricken» countries in terms of quality of life [6]. In 2003 the World Economic Forum ranked Ukraine 84th in terms of its growth in international competitive strength [7].

Notwithstanding the substantial losses suffered, Ukraine still managed to preserve the core of its domestic scientific-technological potential which, taking into account the «economic-technological genetics of our country», is capable, according to scholar Yuri Pakhomov, of achieving the «phoenix effect» [8] and to create the preconditions for a technological breakthrough and a technological revival of the country, even under utter economic dislocation.

Under conditions where research and support of scientific-information of production become a direct force in and are progressively integrated into production and the intensity of research and development (R&D) in production processes also rises, one of the generalizing quantitative criteria for assessing any national economy's innovation potential is the outlays on R&D and education. In developed countries such outlays make up 2.5 percent to 3 percent of GDP, the lowest acceptable level being 2 percent [9]. For example, annual R&D expenditures in the US over the past ten years averaged US$250 billion, accounting for almost half the world's total [10]. The total sum of investments in education seldom falls below 12 percent in leading countries, and in some even reaches 21 per-

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[5] Yu. M. Pakhomov, «Perekhidni ekonomiky Tsentral'noi ta Skhidnoi Yevropy: porivnyannya reformators'kykh zusyl',» *Polityka i Chas* No. 5-6 (1998): s. 48 [Y. M. Pakhomov, «Transitional Economies in Central and Eastern Europe: A Comparison of Reform-driven Efforts,» *Politics and Time* No. 5-6 (1998): p. 48.

[6] Ibid., p. 49.

[7] *Global Competitiveness Report 2003-2004* (Geneva: World Economic Forum, 2003), www.weforum.org.

[8] *Tsivilizatsionnye modeli sovremennosti i ikh istoricheskie korny,* pod redaktsii Yu. N. Pakhomova, redaktory S. B. Krymski i dr. (Kyiv: Naukova dumka, 2002), s. 444 [*Civilizational Models of Modern Times and Their Historical Roots,* principal editor, Yu. N. Pakhomov, eds. S. B. Krymskiy et al. (Kyiv: Scientific Thought, 2002), p. 444.

[9] *Eurostat Yearbook, 2003: The Statistical Guide to Europe, Data 1991-2001* (Brussels: European Commission, 2003), p. 249.

[10] Ibid., p. 251.

cent of the national income. In Sweden, for instance, allocations to education averaged 7.7 percent of the country's GNP, in Denmark, 8 percent, and in Finland, 6.2 percent[11].

In the meantime, innovation funding during the entire period of transition in Ukraine are not only poor in absolute terms, but also show a steady decline with annual decreases in all forms of financing for science and education at rates 1.5 to 2.8 times higher than the actual rates of GDP decline [12]. In 2002, the budgetary share of innovation financing, which is not higher than 0.3 percent of GDP, amounted to 28.9 percent, 2.7 percentage points down from 2001 and 9.7 percentage points down from 1995 [13]. As in previous years, research funding provided by customers prevailed and in 2002 exceeded 60 percent of the previous amount. In this respect, 26.2 percent of total customers are foreign (see Table 1), considerably higher than in developed countries (in the United Kingdom, foreign sources account for about 14.3 percent, in France, for 8.3 percent, in Italy, for 3.9 percent, and in Japan, for just 0.1 percent) [14], and threatens to completely eradicate Ukraine's intellectual potential.

Table 1. **Breakdown of R&D Financing by Principal Sources (in percent)**

Sources of Financing	1995	1996	1997	1998	1999	2000	2001	2002
Total	100	100	100	100	100	100	100	100
State Budget	37.6	39.9	35.4	28.8	27.6	30.0	31.6	28.9
Own Funds	2.2	1.9	2.5	3.1	4.0	3.0	8.7	5.6
Customer Funds:								
Domestic	35.8	34.4	34.0	39.2	38.5	38.4	32.5	35.7
Foreign	15.6	17.1	20.8	23.1	23.1	23.3	22.8	26.2
Other Sources	8.8	6.7	7.3	5.8	6.8	5.3	4.4	3.6

Source: *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 72 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2003), p. 72].

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[11] K. Korsak i L. Yurchyk, «Nauka i osvita na terenakh ob'yednanoi Yevropy,» *Naukovyy svit* No. 11 (2003): s. 6 [K. Korsak and L. Yurchuk, «Science and Education in the Expanse of a United Europe,» *Scientific World* No. 11 (2003): p. 6].

[12] Calculations based on data from Derzhkomstat Ukrainy [State Committee of Statistics of Ukraine].

[13] *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 72 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2003), p. 72].

[14] A. I. Sukhorukov, «Priorytety investuvannya natsional'noho tekhnolohichnoho rozvytku,» *Stratehichna panorama* No. 1 (2003), www.niisp.gov.ua/ [A. I. Sukhorukov, «Priorities for Investing in Domestic Technological Development,» *Strategic Panorama* No. 1 (2003) www.niisp.gov.ua/].

Technological aspects of Ukraine's economic growth and national development are significant in terms of being established in the conscience of the state's political and scientific elite. Thus, the law, «On Priority Directions of Innovation in Ukraine», established the following national priorities until 2007 [15]:

- The modernization of power plants; new and renewable sources of energy; high resource-saving technologies;
- Machine-building and instrument-making industries as the basis for the high-tech renovation of all manufacturing sectors; the development of high-grade metallurgy;
- Nanotechnology, microelectronics, information technologies, telecommunications;
- Improved chemical technologies, new materials, advanced biotechnologies;
- The high-tech-based development of agriculture and the processing industry;
- Transport systems (construction and renovation);
- Health protection and sanitation of human beings and their environment;
- Advancement of an innovation culture in society (support for the publication of books as well as educational and popular research works).

The experience of newly industrial countries and many transition countries supports the public financing of specific policy priorities that are concerned primarily with such technologically advanced sectors of the national economy and are considered decisive for assuring scientific and technological progress for these countries. Extrapolating such programs to current conditions in Ukraine, priority should be accorded to those areas which constitute the foundation of the «knowledge economy», to wit:

- the development of computer networks;
- the development of new generations of chips;
- the creation of high-resolution television;
- new medicines and plant protection means;
- the development of new materials;
- the development of new-generation passenger cars and aircraft, as well as thorough upgrading of railway transport;
- the advancement of environment-friendly technologies;
- the elaboration of new functional biological materials;
- the development of new energy sources;

[15] «Pro priorytetni napryamy innovatsiynoi diyal'nosti v Ukraini, Zakon Ukrainy, vid 16.01.2003,» *Holos Ukrainy* No. 28 (2003): s. 3 [«On the Priority Directions of Innovation in Ukraine, The Law of Ukraine of 16.01.2003,» *Voice of Ukraine* No. 28 (2003): p. 3].

• the creation of a new generation of nuclear reactors and means of instrumentation and control, etc.

To achieve a technological break-through precisely along such strategically important lines, Ukraine possesses such prerequisites as material, intellectual and production resources; however, financial resources to support such projects are scarce.

Thus, in 2002 the overall funding of research and development priorities in scientific and technological development amounted to just over UAH 202 million (7.7 percent of total spending on innovation), or 33.6 percent less than in the previous year [16]. The following methods are used to realize these priorities: state contracts for the development of scientific-technological products; according national status to sectoral scientific-technological programs; and sectoral scientific-technological programs, among others.

At the same time due credit must be given to budgetary sources of funding. In this respect, the leading role of private individuals and structures in financing Ukrainian enterprises (especially small research intensive enterprises) must be emphasized. For this reason, given the favorable conditions for the growth of orders in the manufacturing sector (2.5 to threefold) and the emergence of venture capital funds, a solution can be found not only to the problem of optimizing sources to finance research, but also to that of raising the level of science and high-end technology content and the competitive strength of national industries.

Meanwhile, self-funded enterprises remain the principal source of funds for innovation in Ukrainian industries. These accounted for close to 71.1 percent of total funding in 2002 (Fig. 1). This practice is rooted in the scarcity of other resources and the difficulty of attracting them because of the unfavorable investment climate and the absence of venture capital among other reasons.

Furthermore, financial support of Ukrainian business innovation is characterized by the low use of credit for its expansion. While innovation projects are typically long-term and require substantial input of capital for their implementation, credit resources are mostly short-term and provided at high interest rates. This explains the low proportion of credits (not exceeding 12.6 percent) in the overall pool of financing for innovation in Ukraine.[17]

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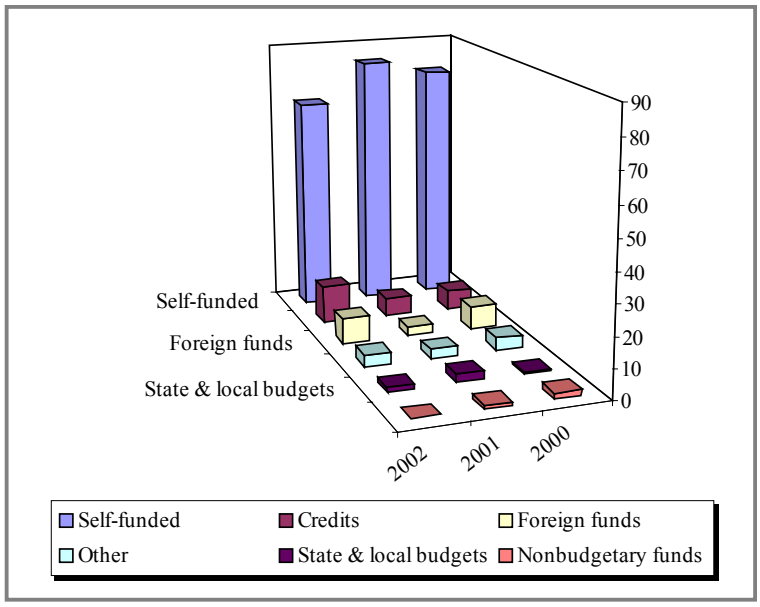
[16] Calculations based on data from *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003) [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2003)].

[17] Calculations based on data from *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 176 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2003), p. 176].

Structure of outlays for innovation in Ukrainian industry[18]



Scarcity of funding sources combined with the low demand for innovation and an inability to pay also has influenced the annual reduction in the number of scientific projects to 41,500 in 2002, half of the figure in 1991[19]. Out of these, 3,100 involved the design of new equipment, 4,200 the elaboration of new technologies, and 900 new materials [20].

A crisis is also apparent in the human resources component of Ukraine's innovation potential, showing itself primarily in the outflow of specialists from the field of science and technology. As evidence in 2002, the number of specialists in R&D fell 64 percent from 1991 levels, including the 32 percent reduction in the number of highly skilled specialists. This is particularly manifest in the number of candidates of science (see Table 2). In addition, a certain regress is observed in the creative activity of scientists, in particular, in the reduction of the number of patents received from four per 100 researchers in 1991 to two in 2000 [21].

[18] Ibid., p. 177.
[19] Ibid., p. 137.
[20] Ibid., p. 146.
[21] *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 319 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2003), p. 319].

Table 2. **Scientific and Technological Potential of Ukraine**

Indicators	1991	1997	1998	1999	2000	2001	2002
Number of organizations involved in performance of scientific research and design work (number of items)	1,344	1,450	1,518	1,506	1,490	1,479	1,477
Percentage of the value of completed R&D related to GDP (percent)	1.8	1.4	1.2	1.22	1.0	1.03	1.13
Number of specialists involved in performance of R&D (in thousands)	295.0	142.5	134.4	126.0	120.8	113.3	107.4

Source: *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 10 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2003), p. 10].

Significant for assessing the scientific and technological resources of any country is the specific number of domestic applications for invention patents. Thus, where 305 applications per 100,000 inhabitants are submitted annually in Japan, less than 18 [22] are submitted in Ukraine. Regarding the number of patents for inventions, a total of 9,178 were granted in 2001, including 67 percent of declaratory patents that were issued without expert examination, and the rest were patents issued for 20 year period (out of which 14.7 percent were issued to foreign applicants) [23]. In 2002, 10,189 applications for inventions were received, out of which about 90 percent [24] were registered.

The observed slowdown of innovation in Ukraine has resulted from such factors as the general decline in production, unsatisfactory dynamics of structural reforms in industry, resource restrictions, etc. While in the mid-1990s the proportion of innovation-active enterprises was assessed at 23 percent, in 2002 it fell to 14.6 percent, a total of 1500 enterprises [25].

Another measure of the effectiveness of enterprises' innovation is the structure of their outlays along the principal lines of innovation. Table 3 shows that the bulk of the overall amount of spending on innovation (over 60 percent) is allocated to capital investment in technological re-equipment of production facilities (acquisition of

[22] Ibid., p. 321.
[23] Ibid.
[24] Ibid.
[25] Ibid., p. 164.

machinery, equipment, etc.), technological preproduction activities (10.8 percent), as well as market research and advertising (10.1 percent), while input of capital in such areas as acquisition of patent rights, licenses, utilization of industrial property objects (3.7 percent) and purchase of non-patent licenses, know-how, and technologies (1.3 percent) was relatively insignificant. Meanwhile, the share of research and development by innovation-active enterprises in 2002 amounted to just 8.9 percent of their spending. Even so, this unimpressive figure was two times lower than that in 1999, providing clear evidence of a significant decline in the financing of such a crucial component of innovation activities in Ukraine.

Table 3. **Breakdown of Total Outlays by the Lines of Innovation Activities**

Indicators	Percentage of Total			
	1999	2000	2001	2002
Total	100.0	100.0	100.0	100
Research and development	15.4	15.1	8.7	8.9
Acquisition of patent rights, licenses for the utilization of industrial property objects	…	2.5	4.7	3.7
Purchase of nonpatent licenses, know-how, technologies etc.	…	1.6	1.6	1.3
Purchase of means of production	67.6	61.0	63.1	61.8
Technological preproduction activities	…	9.3	9.3	10.8
Marketing research, advertising	9.3	4.7	7.9	10.1
Other	7.7	5.8	4.7	3.4

Sources: *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2002), s. 625 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2002), p. 625]; *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 340 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2003), p. 340].

Another measure of the current status of the scientific-technological potential of a country is the number of issued protection documents for industrial property objects and of license agreements for their utilization. Even taking into account the fact that most patents granted in Ukraine are «declaratory» (i.e. registered

without a thorough examination by a scientific-technical expert, thus assuring no full-fledged protection of the industrial property involved), in 2001, out of 1,119 applications for the registration of agreements on assignment of industrial property objects, only 492 such agreements were actually registered, including 62 percent pertaining to marks for goods and services, 30 percent for inventions, and 8 percent for utility models [26]. Furthermore, the extent to which patents are applied directly to production is appallingly low in Ukraine at just 55 percent[27].

In recent years, certain signs can be observed in Ukraine of more vigorous commercial activity in the innovation market. In contrast to the customary Western manner of domestically transferring the results of innovation, Ukrainian enterprises by and large sell their scientific research and development licenses as well as those whose results are not yet implemented, and buy technologies abroad that were developed ten to fifteen years ago, thus extending their life-cycles. Even so, Table 4 shows that over a three-year period the purchase of new technologies from beyond Ukraine declined sharply from 1,465 in 2000 to 337 in 2002, providing evidence that domestic enterprises are reorienting themselves towards innovation projects of Ukrainian developers.

Table 4. **Numbers of Purchased and Transferred New Technologies in and Outside Ukraine Broken Down According to Form of Purchase and Transfer**

Indicators	Purchased New Technologies						Transferred New Technologies					
	In Ukraine			Abroad			In Ukraine			Abroad		
	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002
Total	717	458	1170	1465	314	337	7	9	9	—	1	1
which includes:												
direct purchase of new technologies	21	14	51	5	20	8	5	3	1	—	—	1
Know-how, agreements for purchase / transfer of technologies etc.	251	191	273	875	11	15	1	4	—	—	—	—

[26] Calculations based on data from *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 332 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2003), p. 332].

[27] Ibid., p. 287-291.

Indicators	Purchased New Technologies						Transferred New Technologies					
	In Ukraine			Abroad			In Ukraine			Abroad		
	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002
Results of research and development	115	237	108	2	3	4	—	—	3	—	1	—
Receipt (transfer) of technologies as a component of investments	16	55	11	18	29	31	—	—	2	—	—	—
Leasing	9	1	2	110	—	—	—	—	—	—	—	—
Purchase / transfer of equipment	247	172	627	455	243	232	—	—	3	—	—	—
Other	58	88	98	—	8	47	1	2	—	—	—	—

Source: *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 243 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2003), p. 243].

At the same time, the purchase of licenses abroad has proven to be highly unsatisfactory. Out of the total number of license agreements entered into with foreign counterparts, 62 percent concerned trade marks, mainly in the liquor and tobacco sectors. In terms of inventions, those in the food industry comprised 30.9 percent of total inventions and in the medical field 13.6 percent. Agreements in engineering, electronics, and agriculture were practically nonexistent [28].

The innovative character of development of its strategically important sectors primarily assures the overall growth of the national economy's competitive strength. For Ukraine, these are the subsectors of the machine-building complex. Despite the declining significance of engineering in the total scope of industrial production from 31 percent to 17 percent [29], some hope is offered by the observable revitalization of innovation in this field which has manifested itself in growing volumes of developed and implemented new tech-

[28] *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 333 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2003), p. 333].

[29] Calculations based on data from *Statystychnyy shchorichnyk Ukrainy za 2002 rik* (Kyiv: Tekhnika, 2003), s. 250 [*2002 Statistical Yearbook of Ukraine* (Kyiv: Tekhnika, 2003), p. 250].

nologies and equipment. Thus, the overall number of new models of machines, equipment, devices, instruments, and means of automation implemented for the first time in Ukraine in 2002 grew by 11.5 percent [30] from 2000 levels.

The distribution of innovation results among domestic engineering enterprises does not appear to fully correspond with the priorities of sub-sector development. Specifically, whereas such subsectors as metallurgical equipment production show signs of increase in innovation (including between 1995 and 2002 a 50 percent growth in mining equipment and a 70 percent growth in measuring instruments) [31], their development is crucial for the Ukrainian economy since the production of electronic devices, computers, agricultural machinery, medical devices and machine tools in contrast show signs of declining innovation.

Regrettably, the share of domestic products that are on par with the best Ukrainian and international models continue to decline, falling from 88 percent in 1989 to 70.1 percent in 2000 [32]. Thus, domestic producers are deprived of any competitive advantage in international markets and their outsider status in the field of scientific and technological progress is perpetuated.

An important stage in the process of innovation is that of commercializing innovations, specifically showing the level of their reception by industry. As seen in Table 5, the commercialization process in Ukraine has little to do with the development of new domestic products; this is manifested in particular in the reduction of the share of new developments actually introduced into production from 91 percent in 1995 to 84 percent in 2001.

Also indicative in the commercialization context is the average time needed for the adoption of a decision to introduce new models of machines and equipment into production. In Ukraine, the average time is 9 months[33]. Meanwhile, the growth of the share of models whose production started in the year in which their development was completed is a positive sign, reaching 67 percent in 2001 compared to 51 percent in 1995. In addition, taking into account the average duration of a model's development (1.6 years) and the duration of implementation (9 months), the overall period for

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[30] *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 250 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2003), p. 250].

[31] Ibid., pp. 257-259.

[32] Calculations based on data from *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2001) [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2001)].

[33] *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2002), s. 225 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2002), p. 225].

implementing innovations in domestic enterprises decreased to 2.5 years.

Table 5. **Duration of the Period of Assimilation by Industry of New Models of Machines, Equipment, Devices, Instruments, and Means of Automation**

	Machines, Equipment, Devices					Instruments, Automation Means				
	1995	1998	1999	2000	2001	1995	1998	1999	2000	2001
Total number of models developed	435	253	242	300	321	63	15	24	35	44
Number of which decision adopted to start production –	394	231	208	256	270	57	14	20	34	41
Percent	90.6	91.3	86.0	85.3	84.1	90.5	93.3	83.3	97	93.1
Out of these Production started in the year the model was developed	202	150	120	192	182	18	5	7	16	26
Percent	51.3				67.4					
Production planned to begin in the year following that when the model was developed	144	69	79	55	76	36	9	13	18	14
Percent	36.5				28.1					
Production planned to begin in two or more years	14	3	–	–	–	–	–	–	–	1
No need for serial production	38	21	33	38	50	6	1	3	–	3
Percent	18.8				18.5					
The issue of implementation has not been resolved	3	1	1	6	1	–	–	1	1	–

Source: *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2002), s. 225 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2002), p. 225].

Nevertheless, the unsatisfactory state of the scientific-technological field and the low yield of innovation in Ukraine has resulted in a reduced share of products from innovation in the total industrial output in the country to just 7 percent [34]. This trend also contributes to the reduced efficiency of Ukraine's external economic activities and increases its dependence on imports of research intensive commodities and scientific and technical services, thereby leading to the establishment of labor-intensive and resources-intensive production facilities, as well as facilities detrimental to environment, etc., in the country.

The extraordinarily low share held by Ukraine in the world commercial exchanges of research-intensive and high-technological goods supports this conclusion. Indeed, current Ukrainian exports of products with high value-added does not exceed 0.02 percent of the world total [35]. While post-industrial countries steadily increase their presence in the international markets of scientific-technological products (e.g., countries such as the United States, Japan and Germany command, respectively, 39 percent, 30 percent and 16 percent of the total market of innovative goods collectively valued at US$2,300 billion) [36], Ukraine's external trade is substantially irregular due primarily to the low level of intellectualization and research-intensiveness of its exports.

One of the consequences of the unsatisfactory state of Ukraine's foreign trade is the low share of engineering exports. Thus, in 2001, 73 percent of all industrial enterprises in machine-building sold their products on the domestic market [37]. Exports accounted for just US$1.9 billion (or 58 percent) of the aggregate volume of engineering products introduced in Ukraine for the first time (Table 6), while the share of new types of products in the total export of Ukrainian products was insignificant, not exceeding 10 percent [38].

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[34] Kuchma, *Utverdzhuvaty innovitsiynu model' rozvytku ekonomiky Ukrainy*, s. 13 [Kuchma, *Implementing the Innovation Model for the Development of Ukrainian Economy*, p. 13].

[35] Calculations based on data from *Zovnishnya torhivlya Ukrainy tovaramy ta posluhamy u 2002 rik: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 59-65 [*External Trade of Ukraine in Goods and Services in 2002: Collected Statistics* (Kyiv: Derzhkomstat Ukrainy, 2003), pp. 59-65].

[36] Sukhorukov, «Priorytety investuvannya natsional'noho tekhnolohichnoho rozvytku» [Sukhorukov, «Priorities for Investing in Domestic Technological Development»].

[37] Calculations based on data from *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2002) [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2002)].

[38] *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2002), s. 248-259 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2002), pp. 248-259].

Table 6. **Deliveries and Exports of Novel Engineering Products in 1999—2001**

Indicators	1999	2000	2001
Exports, US$ billion	15.2	18.1	19.8
Exports of new types of engineering products, US$ billion / share of total, percent	.83 /5.5	0.93/5.2	1.9 /9.6
Exports of radically novel products, US$ billion / share of total, percent	.8 /5.3	0.81 /4.5	1.6 /8.1

Source: *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2002), s. 248-259 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2002), p. 248-259].

Specific Features of Venture Enterprises in Ukraine

Apart from industrial enterprises, venture companies are the principal consumers and developers of innovation. Venture enterprise in Ukraine, as in most market economies, has not yet been defined. Under conditions of economic instability and a lack of state influence on economic processes, emerging venture enterprises frequently alter their basic profile and opt mostly for mediatory and sales-related activities. However, under closer examination, small enterprises that engage in scientific research and provide scientific services to private companies continue to function and, in certain regions of Ukraine, have increased their numbers in recent years[39]. Such enterprises may serve as a foothold for the formation of venture capital undertakings, however weak these are today.

Economic outcomes of activities aimed at creating fundamentally new types of products and services are also uncertain and problem-ridden under conditions of economic strife. However, in instances of success, such results yield high profits and lucrative orders for the development of new products. Therefore, only these fields, with their inherently elevated risk factors but promising benefits when successful, may be considered as venture-related. While any kind of activity is fraught with risks under prevailing conditions of economic crisis, venture enterprises, given favorable conditions, are most likely to emerge from small-scale private enterprises.

[39] Calculations based on data from *Statystychnyy shchorichnyk Ukrainy za 2001 rik* (Kyiv: Tekhnika, 2002) [*2001 Statistical Yearbook of Ukraine* (Kyiv: Tekhnika, 2002)]; *Mali pidpryemstva v Ukrainy u 2002 rik: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003) [*Small Enterprises in Ukraine in 2001: Collected Statistics* (Kyiv: Derzhkomstat Ukrainy, 2002)].

Thus, in 2002, 4345 small businesses were engaged in research and development in Ukraine[40]. Such a substantial quantity can be explained by the fact that specifically small-scale private enterprises are most flexible and capable of adapting themselves to the changing economic situation in the country and making the most of the prevailing conditions. This situation reveals the processes of their transformation from one form into another. However, this transformative tendency mostly applies to private and collectively owned small enterprises and cooperatives. International experience shows that venture forms of economic operation function efficiently and develop predominantly on the basis of private and collective forms of ownership. Thus, US public authorities at various levels (federal, state and local) encourage the involvement of entrepreneurial structures in research. Indeed, the rate by which their numbers grew exceeds the rate of growth of the country's population as a whole. Thus, between 1980 and 1997, the US population grew by 17.5 percent while the number of businesses increased by 71 percent, with the highest rate of growth (76.5 percent) demonstrated by independently-owned enterprises which form the bulk of small and medium-sized businesses. However, simple arithmetic reveals that whereas in 1980 one business entity employed, on average, about 17 personnel, in 1997 the figure was barely 11. It follows that in the era of the «new economy», i.e. the era of giant transnational corporations, the spectrum of choice in the economic potential of a country has broadened, not contracted, with the ever expanding role of the individual and human capital in general[41].

In other respects, international experience shows that scarcity of funds becomes a major hindrance for venture companies' research and development. Thus, such funds should be provided out of the state budget and a mechanism for state regulation, both at the local and national levels, is required to assure a comprehensive and well-balanced approach towards outstanding issues of venture business' innovation.

The efficiency of a venture enterprise is hardly feasible without a modern improved scientific-technological infrastructure. In accordance with Ukraine's law, *On the Foundations of State Policy in the Field of Science and Scientific-Technological Activities,* the government is responsible for organizing and coordinating measures

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[40] *Mali pidpryemstva v Ukrainy u 2002 rik: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 20 [*Small Enterprises in Ukraine in 2001: Collected Statistics* (Kyiv: Derzhkomstat Ukrainy, 2002), p. 20].

[41] A. Prokhorovsky, «'Nova ekonomika' aktyvizuye rol' suspil'stva i derzhavy v zahal'nonatsional'nomu rozvytku,» *Problemy teorii i praktyky upravlinnya* No. 34 (2002): s. 47 [A. Prokhorovskiy, «'New economy' enhances the role of society and state in national development,» *Problems of Theory and Practice of Management* No. 34 (2002): p. 47].

for creating such infrastructure. The main components of the innovation infrastructure would be specialized independent institutions and establishments. The principal activities of such entities would include consulting, engineering, intermediary and information services, technopark services, auditing services, venture financing, patent services, management and coordination, etc. Such organizations are currently developing in Ukraine.

In January 1996 the president of Ukraine decreed the creation of technoparks and other types of innovation structures to intensify the development and implementation of novel technologies as well as the training of skilled personnel. The Cabinet of Ministers was directed to work out regulations for a procedure to create and operate technoparks and business development. Local state administrations were ordered to assist in the creation and establishment of such promising entities for research and production.

Particular significance for the innovation sector in Ukraine were the adoption by the Verkhovna Rada of Ukraine of the law, *On a Special Regime for the Investment and Innovation Activities of the Technological Parks «Semiconductor Technologies and Materials, Optoelectronics, and Sensory Devices», «The Ye. O. Paton Institute of Electric Welding», and «The Institute of Monocrystals»* of 16 July 1999 and its amendments in 2001. This law introduced custom tariff preferences and tax benefits for technological parks engaged in the implementation of investment and innovation priorities in research and development. At this time, eight technoparks operate including «Vuhlemash» [Coal-mining machines]; «Institute of Technical Thermal Physics»; «Intellectual Information Technologies»; «Ukrinfotech»; and «Perspektyva» [Future prospects].

The law provides for a five-year exemption from payment of the value added tax (VAT) on sales of goods that are related to the implementation of investment and innovation projects, as well as from the tax on profit. Exemption from payment of the customs duty and the VAT also applies to imports of raw materials, materials, equipment, and other items needed for executing such projects. Nonetheless, inadequate access to financial resources negatively affects the activities in question.

At the Monocrystals technopark, «Alkon», a conglomerate involved in research and development of diamonds, has consolidated the scientific, technological, production and financial capabilities of sixteen organizations, with the Ukrainian National Academy of Sciences' V. Bakul Institute of Extra-hard Materials at its hub. At the expense of internal financial resources, over the last two years «Alkon» attained a five-fold increase in the export of cubic boron nitride micro-powders by taking advantage of the optimally arranged

«science — production» cycle and making use of a number of the Institute's scientific achievements. In addition, it started production on a new generation of diamond-tipped and hard-alloyed tools and introduced a unique new technology of growing large sapphire monocrystals, beginning its industrial production in 2002 [42].

Similar activities are found in other regions of Ukraine. In Lviv oblast, for instance, the «Lviv-Tekhnopolis», was established with over ten small innovation enterprises and has been operating successfully. The Kharkiv Oblast State Administration created «Tekhnokray», a regional program focused on the innovation development of the production and socio-economic spheres in the region. The program provides for a comprehensive approach towards technological retooling of production facilities, thereby creating a modern-day communication infrastructure among others. In addition, a model is being refined for the transformation of Kharkiv into a territory of innovation break-throughs. A working group has been formed of oblast and city officials, managers of industrial, scientific, and educational institutions, and representatives of the national technopark [43]. In Kharkiv the concept for an innovation port and to lay the ground for a national innovation network has been developing within the framework of the technopark and the Special Regime for Innovation Activities (SRIA). An innovation port is a modern-day structural-territorial component of the Ukrainian economy which mainly adapts external technologies and develops and introduces internal technologies. Thus, the convergence of technoparks, techno-»incubators», leading national manufacturers, innovation and investment banks and scientific research and development centers would promote the formation of an efficient nation-wide Ukrainian innovation structure.

In Ukraine the promotion of innovation activities is comparable to such institutional structures as business «incubators.» These first appeared in Ukraine a few years ago with financial support by the polytechnical institute in Troy, US. In particular, business incubators were established in association with the Lviv Politechnic University and the Kyiv Polytechnic Institute. However, the operations of business incubators and other innovation structures have lacked a legal framework and, for this reason, most were dissolved. Nonetheless, they were instrumental in the creation of small innovation entities.

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[42] V. Semynozhenko, «Tekhnolohichni parky Ukrainy: pershy dosvid formuvannya innovatsiynoi ekonomiky,» *Ekonomika Ukrainy* No. 21 (2004): s. 20 [V. Semynozhenko, «Technological Parks of Ukraine: First Experiences of Forming Innovation Economy,» *Economics of Ukraine* No. 21 (2004): p. 20].

[43] V. P. Semynozhenko, «Intelektual'na ekonomika: maybutnye Ukrainy,» *Problemy nauky* No. 6 (2001): s. 2-5 [V. P. Semynozhenko, «Intellectual Economics: The Future of Ukraine,» *Problems of Science* No. 6 (2001): pp. 2-5].

Of critical importance to Ukraine in the context of establishing and expanding a national innovation system and integrating into the international scientific and technological environment is the experience gained by the EU during its process of creating a common innovation space. Indeed, one of the principal objectives of deepening European integration in the fields of science, technology, and innovation has been the fostering of scientific research and technological co-operation among the member countries of this regional organization via the application of the appropriate stimuli. Reasons for pursuing such an objective include the fact that the dynamic pace of scientific and technological progress makes it difficult for each country of the region to undertake independently sufficiently large-scale research and development efforts, let alone develop fundamental science. In consequence, such deepening co-operation in the field of scientific research and technology across national borders along the way has generated new mechanisms for international cooperation in the field.

Thus, western Europe today possesses inter-state centers for carrying out scientific research and implementing joint research programs with the purpose of consolidating the EU's scientific and technological potential and making gains for these countries in those scientific and technological areas where they lag behind their major rivals, the US and Japan, including medical science and biotechnology, communication and energy technologies, space research, information and laser technologies, new materials, robotics and automation of production and transport technologies [44]. Scientific research at these centers is financed out of the EU's budget as well as via indirect and agreed methods adopted for implementing its scientific and technological development strategy. Indirect financing of scientific research involves the participation of public institutions and private companies of member countries, with the EU contributing on average up to 50 percent of the cost of works and acting as a customer at the same time, thus availing itself of the capacity to coordinate R&D and to use the results achieved at the national level, although in the interests of the entire community. In contrast, the agreed financing of scientific work means that research is carried out

[44] Thus, in 1983, with the purpose of co-coordinating joint efforts of member countries in the area of scientific research and development, the first framework program was initiated that introduced mechanisms for the direct support by EU states of basic research. In 1985, the European agency for scientific and technological cooperation, EUREKA, was founded. Its main purpose is to deepen cooperation between the EU countries along the priority lines of research and technology by way of developing entrepreneurial initiatives and establishing new forms for managing and financing cooperation at the inter-company level. In addition, since 1994, a strategic program of research in the field of information systems technology, ESPRIT, has been functioning, and became a component of the framework agreements at the European Union level.

by the individual member country entirely at its expense but in line with EU programs and whereby EU offices only partially coordinate research that promotes exchanges of scientific and technological information and concentrate human, material, and financial resources dispersed across national research organizations in order to achieve specific scientific and technological tasks. There is a trend of increased allocation of financial resources in favor of indirect and agreed financing of R&D within the EU, thereby meeting as much as possible the interests of governments and private businesses of member states.

At the same time, one of the prerequisites for the development of inter-state scientific, technological, and innovation cooperation within the EU was further intensification of national research and development cooperation in its member countries. Thus, a characteristic feature of the United Kingdom, Belgium, Denmark, Portugal, and Germany is the integration of activities between academic institutions and industrial enterprises, as well as companies in various industrial sectors, involving the formation of interdisciplinary cooperation centers, innovation centers charged with the task of transferring new technologies to small and medium businesses, etc. The states not only assist in the extension of such cooperation between companies and scientific establishments, but also detect, assisted by industrial enterprises, the most promising vectors of cooperation in the development of commercially competitive innovations.

Forms of Scientific and Technical Cooperation in Ukraine

Intensification of the international division of labor in science and the adoption by industry of the products of this work have stimulated as an objective the growing need to facilitate Ukraine's participation in international scientific and technological cooperation (accompanied by the subsequent sharing of R&D results) and to diversify such cooperation. The pressing need for this country to modernize technically and technologically all of its productive sectors in order to attain the highest international standards dictates a wide scope of international cooperation in the areas of science, education, and production as well as the most efficient use of its available innovation potential. However, Ukraine's current level of participation in international scientific and technical cooperation is appallingly inadequate and the scope of its involvement does not fully correspond with its scientific, technological and economic potential. At a time when the leading countries of the world are widening the scope of their joint efforts in the field of innovation and diversifying the forms of such cooperation (i.e. taking advantage of cooperation in the scientific and technical aspects of establishing, modernizing and operating industrial enterprises and social infra-

structure; sharing and exchanging technologies, licenses, development and design materials, etc.), Ukraine's contribution remains inadequately diversified, as evident in Table 7.

Table 7. **Level of Intensity of Ukrainian Scientific Personnel's Involvement in International Scientific and Technical Cooperation**

Indicators	Years					
	1997	1998	1999	2000	2001	2002
Number of staff working on contract abroad (in number of persons)	418	540	456	565	427	526
Number of international conferences held	870	817	918	1031	1181	1349
Number of grants received from international foundations	1161	1063	990	1138	1233	1673
Total number of scientific trips abroad	11686	12845	13389	15085	16662	17881
of which number were for the purpose of:						
– internship, training, professional development	1575	1857	1789	1786	2215	2343
– teaching and lecturing	270	268	347	299	390	504
– conducting research	2612	2567	2437	3052	3341	3024
– taking part in international research	4977	5612	5581	6311	7074	4746
Other	2252	2541	3235	3643	3642	4264

Source: *Naukova ta innovatsiyna diyal'nist' v Ukraini: Statystychniy zbirnyk* (Kyiv: Derzhkomstat Ukrainy, 2003), s. 153-160 [*Scientific and Innovation Activities in Ukraine: Collected Statistics* (Kyiv: State Committee of Statistics of Ukraine, 2003), pp. 153-160].

Thus, one form of Ukrainian participation in international cooperation is the participation of scientific personnel in foreign activities. During 1997-2002, the number of foreign trips taken by scientific personnel grew from 11,686 to 17,881, or by 53 percent; those for the purpose of internship, training and professional development increased 48 percent and conducting research by 15 percent. However, while the participation of Ukrainian researchers in international research increased 42 percent between 1997 and 2001 from 4,977 to 7,074, the level dropped 36 percent in 2002. Nevertheless, the other categories strongly demonstrate an increase in Ukraine's involvement in these forms of international cooperation, specifically, the number of international conferences held and the number of grants received from international foundations (an increase of 23

percent in 2002 from 2001 figures), etc. Indeed, Kyiv and Kharkiv oblasts obtained over 50 percent of the grants received from international foundations, which were mostly distributed between such fields as physics, mathematics and medicine.

A new and promising trend in Ukraine's international scientific and technical cooperation has been the progressive development of cooperation with leading countries in R&D and modern education and who have attained significant success both in theoretical and practical research. At this point, Ukraine has closest ties in the field of scientific, technical and educational cooperation with the EU countries, the US and countries of the former Soviet Union. It is also party to over thirty intergovernmental accords that have laid the ground for such cooperative relationships. For example, Ukraine has been part of EU initiatives in the field of scientific and technological development by way of INTAS, TACIS and COPERNICUS among others. Cooperation with the US mostly proceeds via American international foundations (such as the Civil Research and Development Foundation) and NATO's academic programs among others. Within the framework of these programs, Ukraine has been steadily receiving financial support for the development of domestic research; for instance, NATO funded over 480 grants for Ukrainian scientists and the participation of 300 Ukrainian scientists in its scientific fora[45]. Nonetheless, the overall financial volume supporting Ukraine's international scientific and technical activities remains too small to affect significantly the social and economic development of this country.

Despite Canada's leadership in a number of mostly research-intensive and complex sectors, such as nuclear power engineering, aviation and space technology and modern communication systems, biotechnology and pharmaceuticals, regrettably cooperation between Ukraine and Canada is concentrated mainly in the area of «medium» technologies. Canadian investments comprise only 1.3 percent of all foreign investments in Ukraine, with the primary target sector of such investment being industry (72.9 percent) and in contrast with machine-building (8.8 percent)[46]. Nonetheless, high-tech-related projects are also carried out in the framework of Canada-Ukraine cooperation and merit attention, especially those in the medical field. For instance, Pharmascience entails the manufacture of medical supplies for the Ukrainian domestic market and for exports to Russia and Belorus. In-

[45] M. Zhurovs'ky, «Naukovo-tekhnolohichny rozvytok Ukrainy za umov svitovoi globalizatsii,» *Dzerkalo tyzhnya* No. 2 (2002): s. 12 [M. Zhurovsky, «The Scientific and Technological Development of Ukraine Under Conditions of Globalization,» *The Weekly Mirror* No. 2 (2002): p. 12].

[46] According to data from the Ministry of Economics, Office of Bilateral Cooperation in the Field of International Trade Agreements.

deed, sales of Pharmascience products have shown an annual growth of 30 percent. Cooperative projects have also been launched in the field of consulting services with Romyr and Associates and the Citizens Network. All of these activities speak to the potential identified in the 2002 report by Canada's Senate Foreign Relations Committee, «Canada, Russia, and Ukraine: Building New Relations», which declared Ukraine as a source of a dynamic and highly educated workforce and detailed plans for bilateral cooperation in various fields, especially in education[47].

Russia and other members of the Commonwealth of Independent States (CIS) play an important role in Ukraine's international scientific cooperative activities. The formation of a common scientific-technological space among CIS countries assumes special significance in this regard. Indeed, a Concept for strategic innovation of the CIS countries by 2005 was developed in order to foster inter-state innovation activities in the field of science and technology[48]. Its primary purposes are to enhance the technological standards and competitive strength of industry, to assure access to internal and international markets of CIS innovative products and to achieve substitution of imported products in the domestic markets. Accordingly, inter-state innovation policy priorities are to be formulated with due account of the importance of scientific and technological development, the elaborated strategies and concepts for developing areas in the real sector of the economy, high-tech spheres and the most efficient R&D results attained in the framework of national programs. The following programs are destined to assume inter-state status by 2005: resource conservation; an integrated technological base among CIS states; new materials; CALS[49] technologies; small business development in CIS countries; training of management personnel in science and industry; and information marketing centers. Even so, the development of high-tech sectors and economic trends must be supported by national target programs. In this respect, much attention is given to technological development programs intended to serve as a basis for the manufacture of those competitive products for which market niches have been clearly identified and for which experience has shown a demand.

The combination of inter-state innovation programs, national innovation target programs, technological development programs and

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[47] *Canada, Russia and Ukraine: Building a New Relationship*, 16th Report of the Standing Senate Committee on Foreign Affairs, Ottawa, June 2002, www.parl.gc.ca.

[48] «Soglasheniye o sozdanii obshchevo nauchno-tekhnologicheskovo prostranstva gosudarstv-uchasnikov Sodruzhestva Nezavisimykh Gosudarstv,» *Innovatsii* No. 1 (2002): s. 6-7 [«Accord on the Creation of a Common Scientific and Technological Space of CIS Member Countries,» *Innovations* No. 1 (2002): pp. 6-7].

[49] Continuous Acquisition and Life-cycle Support.

individual specific innovation projects generates a favorable environment for raising the competitive strength of products manufactured in CIS countries. With the support of the CIS countries, institutional reform in the scientific and technological areas and a package of financial, economic, and organizational measures will be instrumental in creating an integrated inter-state innovation system that embraces effectively operating national systems, substantially increasing the number of innovation-active enterprises, and assuring an innovation-intensive development of the industrial production structure that satisfies the needs of the CIS population [50].

Another CIS body called upon to raise the effectiveness of inter-state programs and projects is the inter-state fund for support of innovation activities in the scientific and technological sphere. Distinct from other bodies and predominantly supported by annual allocations from the budgets of countries that are parties to the relevant accords, the fund eventually will be self-financing. The fund provides for the development of science, technology and equipment for the implementation of inter-state programs and their priorities and according to the concentration of CIS innovation resources.

Destined to become the most significant step towards the creation of an integrated scientific-technological space, the 2001 accord of CIS member-countries interpreted a common scientific-technological space as an environment where these countries shall carry out mutually harmonized policies in respect of priority fields of science and technology that are of common interest. The content of individual policy components and the relevant national regulatory frameworks will be subject to such harmonization. In this respect, the formation of the normative and legal frameworks for the support and development of the accord as well as a guaranteed level of state funding are the main prerequisites for the successful realization of the accord. However, none of these have yet been achieved by any of the CIS countries, including Russia and Ukraine.

At the same time, given the world-wide internationalization of science and the available scientific and technological potential of Ukraine, the development and implementation of joint scientific projects and programs with foreign groups would allow the Ukrainian partners to significantly cut the costs of innovation. One method of facilitating such efforts at international scientific-technological cooperation is the collection in Ukraine of proposals and suggestions from aca-

[50] «Kontseptsiya mezhgosudarstvennoi innovatsionnoi politiki gosudarstv-politiki gosudarstv-uchasnykov Sodurzhestva Nezavisimykh Gosudarstv na period do 2005 goda,» *Innovatsii* No. 7 (2001): s. 14 [«Concept of the Inter-State Innovation Strategy of CIS Member States Until 2005,» *Innovations* No. 7 (2001): p. 14].

demic institutions and research institutes regarding the possible performance, jointly with foreign counterparts, of R&D projects in the following areas of scientific and technological advancement: power engineering and energy conservation; science and technology of materials; automation, electronics, and telecommunications; biology; medicine; construction and architecture, etc. In addition, in the context of such cooperative ventures, each specific area of cooperation should be assigned to a scientific research organization that would coordinate the research. A list of such authoritative entities may include the Paton Institute of Electric Welding, the Institute of Extra-hard Materials, the Glushkov Institute of Cybernetics, and the Institute of Pediatrics, Obstetrics and Gynecology among others.

Experience shows that direct ties between educational establishments represent the most effective form of international cooperation in the field of higher and specialized education, providing the outlet for sharing knowledge, training techniques and innovations imperative for the formation of highly skilled personnel competitive in the labor market. Indeed, a substantial amount of research already is carried out in institutions of higher education. In the first place, cooperation among institutions of higher learning (colleges and universities) in Europe is another important condition of scientific, technological and social progress. Examples of forms of such cooperation include joint academic conferences, round table discussions, and symposia; joint production of textbooks, studies, projects; internship abroad of lecturers, postgraduates, and doctoral candidates; practical work abroad of students and business trainees; and the facilitation of publications abroad among others. The expansion of cooperative relationships with foreign counterparts in the field of innovation would accelerate scientific progress, contribute to the structural readjustment of production, shorten the time lag between the development and implementation of innovations, and facilitate the development of production in Ukraine of specific scienctifically-intensive products.

Conclusion

The current phase in the development of world economic ties is determined by the growing dependence of national economies on technology and information. Innovation, production and the development of basic scientific disciplines require large-scale financial and material inputs and powerful personnel and infrastructural support. For these reasons, their confinement to a single country by and large is not always economically justifiable. Thus, based on commonly accepted international criteria Ukraine possesses a fairly sub-

stantial and promising potential for innovation (from the perspective of mainstream basic and applied science). However, at this point it is far from being fully exploited. There are several reasons for this. First, Ukraine is in urgent need of technological and structural renovation and increased financial support for innovation. Second, it requires extensive and diversified forms of international scientific and technological cooperation with other countries.

In this respect, one issue of particular urgency for Ukraine is the establishment of a venture financing industry. International economic experience shows that in countries with well-developed markets, venture undertakings play an active role in satisfying the need of the population for novel products and in raising the overall scientific and technological level of production, thereby creating a competitive environment in the fields of science and scientific services.

Moreover, entrepreneurial entities such as «incubators», technocities and technoparks can be instrumental in advancing innovation in Ukraine and scientific and technological cooperation with international partners and countries. Specifically, incubators can be associated with scientific institutions and educational establishments; their activities could include scientific consultations, advanced expert examination of projects, financial support via venture mechanisms, etc. Regarding technocities and technoparks, such entities should not limit their activities in Ukraine to innovation projects and implementation of these results in industry; structures of this kind may also act as centers of international cooperation in publishing and after-sales service and form a socio-cultural environment favorable to innovation.

Industrial-financial groups, a specific form of cooperation between industrial technological complexes and credit-financing structures, can play a role in facilitating Ukraine's international scientific and technological cooperation. Within the framework of such amalgamations, thanks to the merger of Ukrainian and foreign capital, managerial skills and innovation achievements, the efficiency and effectiveness of innovation can be substantially enhanced, thereby contributing to the acceleration of scientific and technological advances and the structural reform of production facilities among other concerns.

A final promising, economically advantageous and encouraging avenue for enhancing Ukraine's international scientific and technological cooperation is to extend the scope of its cooperation with other states in the field of education, to foster international academic ties by establishing direct contacts both between institutions and between individual representatives of Ukrainian and foreign schools. This form of cooperation is required in order to promote a new generation of highly skilled personnel as well as exchanges in knowledge and experience.

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