Chapter 6

EVALUATION OF CROATIAN INNOVATION CAPABILITY

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ABSTRACT

In this paper we try to assess and evaluate Croatian innovation capability thorough the framework of the European Innovation Scoreboard (EIS), a system of innovation indicators. Economic theory perceives innovation as a source of national competitiveness and the EU set the ability to compete within the single market as the main economic criterion for EU accession. Through the use of EIS indicators we are able to compare and rank Croatia's achievements in innovation policy against EU and Central and Eastern Europe countries (CEEC). Croatia ranks well by European standards in comparison to other CEEC, in particular Bulgaria and Romania, but has not made a significant progress in its innovation potential and policy with respect to the EU.

Key words:
innovation policy, national innovation system, European Union integration processes, knowledge-based society, European Innovation Scoreboard, Community Innovation Survey, Croatia

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INTRODUCTION

Croatia's economic policy has since the beginning of the transition devoted a lot of attention to macroeconomic policies and reforms, while innovation policy has developed under the umbrella of research and development (R&D) policy. This approach has neglected the potential of innovation policy to contribute to higher economic growth. The first elements of innovation policy in the form of technological programs appeared only few years ago. The focus of this paper has been placed, accordingly, on assessment of the elements and setup of innovation policy in Croatia. The paper consists of two major parts. In the first part, we explain why it is important to activate the national innovation policy and in the second part we try to recognize the strengths and weaknesses of Croatia's innovation potential and policy.

The significance of innovation policy for the economy has traditionally been recognized more strongly in advanced economies. In the Lisbon European Council in March 2000, the EU set out its long-term strategy of becoming the most competitive and dynamic knowledge-based economy in the world. Innovations are therefore perceived as a foundation of the transition to a knowledge-based society and innovation policy has become the central strategic tool in achieving competitiveness in industries and consequently, in the maintenance and stimulation of economic growth in the EU. In the light of the enlargement of the EU, all CEEC, including Croatia, must establish and develop a modern national innovation system (NIS). This should also help Croatia create the key conditions for achieving long-term economic development. We assess Croatian innovative capability through the European Innovation Scoreboard which consists of a number of standardized indicators of innovative performance.

Detailed analysis of Croatia's innovation policy and potential provides encouraging results in some areas of human resources development, for example, the share of science and engineering (S&E) graduates of the 20-29 year age class. However, another important aspect of human resource development – life-long learning – is totally neglected and sees Croatia at the end of CEEC and EU rankings. While the high-tech services sector appears relatively developed in Croatia, the high-tech manufacturing sector is clearly underdeveloped. Knowledge creation is an area where policies have obviously failed – expenditures on R&D, both public and business, are insufficient. Also, European Patent Office (EPO) applications by Croatian residents are the lowest in CEEC.

The transmission and application of new knowledge also require additional progress, especially in promoting a business innovation culture.

We conclude that Croatia has not made significant progress in its innovation potential and policy as compared to the EU, but by European standards ranks well in comparison to other CEEC, in particular Bulgaria and Romania.

INNOVATION POLICY: THE CENTRAL STRATEGIC TOOL IN ACHIEVING COMPETITIVENESS AND GROWTH IN EUROPEAN UNION

The rise of the new economy formed in the context of globalization and the increasing importance of information and communication technologies (ICT), have pushed the EU to establish a long-term strategy to become the most competitive and dynamic knowledge-based economy in the world. The transition towards a knowledge-based society is perceived as a way of keeping pace with the EU's global competitors. At the Lisbon European Council Summit held in March 2000, innovations were perceived as a foundation of the transition to a knowledge-based society (Council of European Union, 2000a; 2000b). Therefore, innovation policy has become the central strategic tool in achieving industrial competitiveness and consequently, in maintaining and stimulating economic growth in the EU.

The EU approach to innovation policy is multifaceted. Elements of innovation policy are found in both industrial and enterprise policy. That attitude is reflected in the Lisbon Strategy (the official document of the Lisbon Council Summit), which proposes the establishment of a European Area of Research and Innovation and the creation of an environment friendly to starting up and developing innovative businesses. Small and medium-sized enterprises are seen as drivers of innovations. As a way of ensuring the achievement of these goals, the EU proposed the encouragement of key interfaces in innovation networks: between companies and financial markets, R&D and training institutions, advisory services and technological markets. The conclusions of the Summit are not likely to remain at the level of declaration, but are rather well envisioned in formal documents in terms of financial planning, effective monitoring, assessing and evaluating.

The importance of the strategic determination towards strengthening innovation processes in the EU is visible in the follow-up events. The Barcelona Summit in March 2002, where the European Council reviewed the progress made on basis of Lisbon Strategy, confirmed the commitment to fostering innovation and called for a more significant boost in overall R&D and innovation activities in the Union (Council of European Community, 2003d). In the conclusions, the Council expanded requirements for R&D spending (aimed to reach about 3% of GDP by 2010, with 2/3 of the investments coming from the private sector). Moreover, a call was made to strengthen business R&D through an integrated strategy involving increased competition on product markets, better access to venture capital, as well as better protection of intellectual property rights, and improved networking and technology diffusion. The Commission's Communication on Innovation Policy in 2003 also expanded policy conclusions based on the Lisbon strategy (Council of European Community, 2003d). The Communication asked for a broadly-defined concept of innovation, so that policy design would not omit less obvious or known types of innovation. It also demanded that innovation policy's interaction with other policy areas such as industrial policy be better coordinated and followed up.

In the Communication "Industrial Policy in an Enlarged Europe" innovation is outlined as a key factor of industrial competitiveness together with knowledge and entrepreneurship (Council of European Community, 2003c; European Commission, 2004c). The Communication states that European industry needs to become more innovative by constantly initiating, refining and improving its products, services and processes. The kind of innovation created through the development of a risk-taking mentality among entrepreneurs is stressed. The Green Paper on Entrepreneurship considers innovation one of the key challenges (Council of European Community, 2003a; 2003g). One of the priorities of the Paper is that innovation in the business context be promoted.

CROATIA'S INNOVATION POLICY IN THE LIGHT OF THE FUTURE EUROPEAN UNION ENLARGEMENT

Croatia has since the outset of its political transition to democracy been oriented towards joining the EU and has throughout that period made serious steps towards achieving its goal. In its answers to the Questionnaire of the European Commission in 2003, which later served as a base for obtaining candidate status for EU accession, Croatia put the establishment of a modern innovation system among its microeconomic and structural priorities. This is envisaged as helping Croatia to create the key conditions for achieving long term economic development. The modern innovative system that the country aspires to was defined as a system that encourages cooperation among the educational and scientific system, technology development, government institutions and private enterprises. The European Commission granted Croatia candidate status in 2004. In its *Opinion* on Croatia's application for EU membership (Council of European Community, 2004), the Commission regards Croatia as a functioning market economy. However, the Commission added that greater efforts had to be taken in the field of innovation policy to make the country competitive and efficient at the European level. Firstly, as an overall measure, government expenditure on research and development in Croatia (1.09% of GDP) is below the EU average (1.99%), as is the share of private sector expenditure on research and development (0.45% of GDP in 2002 in comparison with the EU average of 1.3%) (CBS, 2003). Secondly, changes are needed in scientific and higher education policies in order to integrate them into the European Research Area.[i] A national industrial strategy, which should incorporate elements of innovation policy in order to raise industrial competitiveness, has not yet been adopted independently of the general economic policy. The enterprise policy, another complement to modern innovation policy, is assessed as small and medium-sized enterprise (SME) policy in the formal documents. Innovation policy is integral to SME policy in that it has put forward the Croatian Innovation Technology Development Program (HITRA) specifically aimed to support technology transfer to new technology-based firms with financial and non-financial incentives.

On the national level, a politically independent advisory body that tries to foster and improve Croatia's competitiveness – the National Competitiveness Council (NCC) – put the development of innovativeness and technology as one of the top political and economic priorities. The Council perceives innovation as a permanent basis for maintaining competitiveness through productivity improvements. This view is in line with the EU's strategic determination to become a knowledge based-economy by fostering innovation. The results of the Council's work are embodied in a document entitled *55 Recommendations for* *improving Croatia's competitiveness* which may serve as a basis for political decision making (National Competitiveness Council, 2004). In the document, innovation policy is addressed in terms of "what it should become" and not in terms of "what it is at the moment". Therefore, the Council outlined several principles that should help Croatia move towards a modern approach to innovation policy and as an outcome strengthen links among technology, innovativeness and economic growth. Those principles are designed for the establishment of a market-oriented innovation policy that will: strengthen components of innovation capability (absorptive capacity, demand, innovation diffusion and R&D), lead to productivity growth and strengthen the knowledge component in new investments.

THE IMPORTANCE OF INNOVATION FOR ECONOMIC GROWTH AND COMPETITIVENESS

Understanding the theoretical links between economic growth, competitiveness and innovation could promote the role of innovation in Croatia's public and political life. There is a general consensus among economists that technological innovation plays a central role in the process of long-run economic growth (Radosevic, 2003a:4).

Innovations in economic growth theories and models

While neoclassical growth theory did not elaborate how technological progress is achieved, although it perceives it as a source of growth, endogenous growth models have gone further. In endogenous growth models (models based on externalities, Neo-Schumpeterian models and AK models) technological progress continues to be the main source of growth, but technological progress is perceived as a result of activity of a particular entity – a firm or individual (Romer, 1986:1990).[ii] In models based on externalities, learning from other firms on the level of an economic branch leads to new ideas that may result in technological progress. Knowledge, which is considered identical to technological progress, cannot be protected, and is therefore free and can spill over. Neo-Schumpeterian models are based on a belief that research and development can spur economic growth (Grossman and

Helpman, 1990; 1991; Aghion and Howit, 1992). These models function under the assumption of imperfect competition. Under that assumption, firms will have an interest in innovating because now they can protect their innovations via patenting and earn extra profits. In AK models, growth is a consequence of capital accumulation, while technology is not treated as a special type of good, which makes these models less sophisticated than their predecessors.

Apart from their concern for growth, transition economies have shifted their focus towards competitiveness, particularly so in the light of the need to catch up with the EU as well as of withstanding competitive pressures within the Union (Radosevic, 2003a). The role of innovation for the success of a nation and its industries is discussed in Porter's work embodied in "The Diamond of National Advantage".[iii] Porter (1990:73) recognizes that competition revolves around the creation and assimilation of knowledge. For him, a nation's competitiveness depends on the capacity of its industry to innovate and upgrade.

Porter's approach to innovation

Although Porter asserts that the national success of various countries can derive from combinations of different factors, he determinedly dismisses widely held beliefs that government policies such as an active exchange rate and antitrust policy will spur an economy. Instead he turns to the examples of industries that have succeeded on the global scene and asserts that companies achieve competitive advantage through acts of innovation (Porter, 1990:74). At the individual firm level, innovation is not only perceived as introduction of new technology (resulting in new products) but can also be seen as innovation in processes and organization (new in-house processes). However, the international dimension of innovation is stressed – innovations must be marketed internationally in order for firms to be considered to have a competitive advantage. Porter believes that successful innovations will arise when companies are under strong competitive pressure, irrespective of their innovative activity perhaps being faced with criticism and significant obstacles. Keeping the competitive edge is seen as a continuous process of improvement and upgrading. This is due to the fact that competitors are likely to be able to imitate any given competitive advantage.

INNOVATION CAPACITY IN CENTRAL AND EASTERN EUROPE

Strategies for achieving and maintaining long-term economic growth in CEEC during the 1990s disregarded the role of R&D systems or the role of innovation activities. Public innovation policies only emerged at the end of the 1990s, while institutional R&D systems have still not been restructured. Growth and innovation in an economy generally depend on R&D, on the capability to absorb and diffuse technology and on the demand for its generalization and utilization – elements which form the conceptual framework of a national innovation capacity (NIC).

> **Elements of national innovation capacity**
>
> (*1) Absorptive capacity* is the ability to absorb new knowledge and adapt imported technologies. *(2) R&D capability* is important not only to generate new knowledge but also as a mechanism to absorb it. *(3) Diffusion* is the key mechanism for reaping economic benefits from investment in R&D and for increasing absorptive capacities. *(4) Demand for R&D and innovation* is the key mechanism that initiates wealth generation processes in R&D, absorption and diffusion activities (Radosevic, 2003a:8).

A large base of research scientists and engineers coupled with a relatively well educated working force were two strong starting points of national innovation systems in CEEC.

> *A National innovation system* is a system consisting of: policy measures and programs, technological institutional infrastructure and policy control mechanisms (Švarc, 2004).

The institutionalized R&D base has shrunk over the transition period due, on the one hand, to the decreasing amount of R&D public expenditure as a proportion of GDP, and on the other, because there has not been sufficient technological upgrading in firms. The financing of institutionalized R&D by industry was quite diverse across the region, ranging from strong connections to utterly weak and the intensity of that cooperation was determined by the country's industrial structure. Deindustrialization in some CEEC was quite abrupt, with services taking stronger shares in the economic structure, and at the same time growing above the industry average. Overall, partial loss of government funding together with weak demand from the industry have pushed the modernization and restructuring of R&D systems into neglect.

CEEC is lagging behind the EU in all aspects of NIC and most pronouncedly in its capacity to generate demand for innovation, which may be defined as the level of the development of the financial system, the degree of competition and macroeconomic stability or shares in foreign direct investment (FDI). Evidence on the state of NIS in former candidate countries points to strong disparities (Council of European Community, 2003a:11). In comparison to the former EU-15, the new members (as of May 2004) had pronounced aversion to risk, underinvestment in R&D and poorly developed science and research-business links. It appears that all of the new members have a common difficulty in the area of innovation policies, which have not yet become autonomous, fully-fledged policies. The institutional setting for implementing innovation policy is not well coordinated, human and financial resources are scarce, and the capacity of businesses to absorb knowledge and then apply it is low.

Consequentially, the relationship between domestic innovative activity and economic growth from a sample of eight CEEC is unclear (Radosevic, 2003a). It appears that frontrunner economies (the Czech Republic, Slovakia, Hungary and Poland) are not the countries with the highest number of registered resident patents. That would imply that innovations are not a driving force behind growth in CEEC. Also, the causality from economic growth to innovation is not straightforward. Both economic rise and decline have in the past led to a decline in R&D, suggesting that higher economic growth may not necessarily lead to higher innovative activity. Improved goods and services demand and supply conditions in CEEC at the end of 1990s might have contributed to the larger adoption of new technologies, but that did not happen. Apart from recognizing that domestic firms had difficulty in financing their activity, strong "brand" competition (though trade and FDI) might have also hindered catching-up in technology.

When examining the cost structure of innovative activity in CEEC, it seems that R&D is less important than buying new technology, while the trend is quite the opposite in the EU, where R&D has larger share in innovation expenditures than the acquisition of new technology. The business environment is the main source of innovation information, and not information within the firm (which is the case in more developed countries). A part of this business environment consists of foreign investment enterprises (FIE) – and world estimates are that most new innovations occur in multinational companies (MNC). However, it seems that the transfer of technology from MNC in CEEC was confined to FIE (cf. Biegelbauer, Griebler and Leuthold, 2001). Transfer of technology from FIE to local firms might have occurred only in the countries that have received the most significant shares of FDI into export-oriented internationalized activities such as the automobile or electronics industry and where FIE have worked with local suppliers and contractors (Poland, the Czech Republic and Hungary). Radosevic (2003b:9) points out that corporate reliance on external information and the external setting raises the importance of NIS – since innovation capabilities of firms are dependent on the systemic features of the external environment in which they operate.

CROATIAN INNOVATION POLICY

The first elements of innovation policy in Croatia only emerged in late 1990s (Švarc, 2004). The reason behind the marginalization of innovation policy can mostly, on the one hand, be attributed to the importance given to macroeconomic policy, in particular to macroeconomic stabilization and reforms, monetary and fiscal policy objectives etc. On the other hand, the understanding of innovation policy in Croatia was obsolete and traditional in that it perceived that innovation policy should primarily be based on fundamental research. That traditional view hindered the development of the applied sciences and their commercial use as well as postponing the modernization and reorganization of the general research and science institutional setting and policies. Evidence to that effect is found in the fact that the Ministry of Science and Technology was the sole body responsible for innovation policy, but perceived it as technological and science policy from the beginning of the transition to the late 1990s.[iv] On the positive side, the traditionalist approach to science and technology prevented the diffusion of a broad knowledge base. The government was mostly focused on the modernization of higher education, but with no consequences to the science and research system which under Government financial support remained non-autonomous. The National Science and Research Program of 1996 served as a formal base for setting up the first network of institutions for technology transfer. The centers were founded in Zagreb, Rijeka, Split and Osijek with the mission to serve as institution-technology interface centers between universities and business community. The Program from 1996 also envisaged the creation and implementation of measures for innovation-based businesses.

The research "market" was also impoverished by the disappearance of many industrial institutes, which had been the driving force behind technology and innovation development in the past, as they were left to the care of the market and their founding companies. As a result, only a few of those institutes remained alive and successful. The turning point in innovation policy development was in early 2000, when programs promoting cooperation between industry and R&D systems were introduced. The HITRA was launched in 2001 by the Ministry of Science and Technology and it aimed at building up an efficient NIS through permanent development of three strategic long-term goals: (1) the creation of stimulative policy measures, mechanisms and programs; (2) the creation of a technological institutional infrastructure and; (3) the establishment of control mechanisms of policy for innovation and technology (National Competitiveness Council, 2004). It was with these programs that the development of entrepreneurship and the technological upgrading of firms was specifically targeted. The introduction of these programs was a step towards a modern approach to innovation policy that is found in the Triple Helix model, which consists of three basic actors intertwined in their actions – the government, universities and businesses – the goal being to shorten the time span between discovery and utilization.[v] Nevertheless, the programs did not manage to strengthen the whole all of the elements of the model, and in particular they have failed to promote links between R&D and businesses. The element of the model that was most promoted is the link between the Government and the R&D sector. So far, the Croatian NIS has been characterized as having a weak sector of industrial R&D and low level of technological capabilities of business. Implementation of HITRA and its contribution to the development of the Croatian NIS has so far been insufficient.

Considering the fact that innovation policy has been operational only over the last four years, its estimated impact on research and development, and in consequence on economic growth, could only have been modest and therefore, will not yet be visible.

METHODOLOGY AND DATA

The theoretical framework of technological changes assumes that there is an R&D sector which, in interaction with demand for R&D

by innovators, generates innovations (Radosevic, 2003a:5). Our goal is to examine the state of demand for innovations and the pool of innovations in Croatia and make a comparative analysis with the EU and its new members. We use the EIS as a framework of our analysis. It was originally created for tracing progress towards the EU's strategic goal of becoming the most competitive and dynamic knowledge-based economy in the world (European Commission, 2004:4) and it consists of 17 indicators divided into four categories relevant to the innovation process. Those categories are: human resources, knowledge creation, transmission and application of new knowledge and innovation finance, market and output. Countries already included in the Scoreboard's sample are the EU-15 and the new members of the EU as of May 2004 and Bulgaria and Romania.

Human resources is a category that approximates the quality scale of human resources as a major determinant of knowledge creation and the transmission and application of new knowledge.[vi] This category is recognized as the most important source of knowledge in particular countries. The human resources category includes five indicators divided into two groups: education and learning, and employment. The indicators related to education and learning are: percentage of S&E graduates of the 20-29 year age class in the population, the percentage of the population with tertiary education, and participation in life-long learning. The group related to employment comprises two indicators: the number of employed in medium and high-tech manufacturing and the number of employed in high-tech services.

Knowledge creation as category measures inventive activity. Knowledge creation as a process enhances inventions which are prerequisites for innovation activities. Its indicators are: public R&D, business R&D and patenting. Patenting has two sub-categories (1) high technology patents at the EPO and high technology patents at the US Patent Office (USPTO) and (2) EPO applications (per million population) and USPTO applications (per million population).[vii]

Transmission and application of new knowledge presents a link between an invention concept (a thing or an idea) and an innovation term (introducing new things, ideas or way of doing something). Transmission and application of new knowledge as category covers innovation activities such as the adoption of new equipment to a firm's production and service systems, adopting innovations developed by other firms and organizations, and adapting new knowledge to the firm's specific needs (European Commission, 2001:6). This category includes the indicators: SMEs innovating in-house manufacturing, SMEs involved in innovation co-operation and innovation expenditures.

We start by compiling indicators for CEEC available to us from the Scoreboard Report and set their values of indicators against the EU average value in 2003.

Due to the unavailability of data for Croatia in the Scoreboard's category *Innovation finance, market and output*, we omit this category and focus on an analysis of the series of 12 indicators comprised in the other three categories: human resources, knowledge creation and transmission and application of new knowledge.

Data for constructing Croatia's indicators are collected from sources at both macro and micro-level. Macro-level data are taken from the Central Bureau of Statistics (CBS), ministries and government agencies. Firm-level data are available to us from the preliminary results of the Croatian Community Innovation Survey (CIS) carried out within the framework of "Statistics of innovation in the Republic of Croatia" (mimeo) project by The Institute of Economics, Zagreb.[viii] Surveys of this kind have already been conducted in over 30 European countries and are aimed at collecting innovation activities data and usually serve as statistics bases available to innovation policy makers. The statistics include manufacturing and service sectors data on product and process innovations, expenditures on innovation activities, in-house research and development.

The Croatian CIS is carried out in 3,749 firms with over 10 employees belonging to the sections of Mining and Quarrying, Manufacturing, Electricity, Gas and Water Supply, Transport, Storage and Communication, Financial Intermediating and subsections: Computer and related activities, Research and development, Architectural and engineering activities and related technical consultancy, Technical testing and analysis.[ix] The period under observation is 2001-2003. The sample used for the purposes of constructing indicators in the transmission and application of new knowledge category is smaller than in the other categories and amounts to 600 firms. We expect the final values in this category to be lower than the preliminary ones that we are using.

In our analysis, we are forced to adapt the framework of Scoreboard indicators because an application of a single methodology across the sample of countries is not possible. The analysis will allow us to rank Croatia against EU countries and other accession countries in the monitoring period and assess the country's progress towards EU in the area of innovation activities and technological changes.

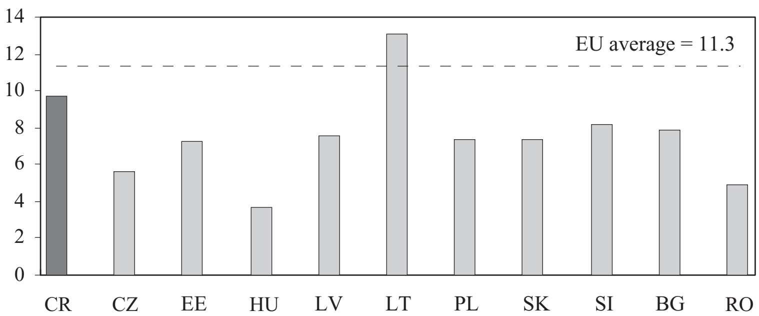
INDICATORS ANALYSIS

Human resources

The first category of indicators is related to the state and potential of human resources. They approximate achievements in education and life-long learning and are combined with employment in medium-high tech industries and services.[x] Within this category, Croatia ranks relatively well in comparison to the rest of the CEEC as well as in comparison to the EU average.

Science and engineering graduates indicator is a measure of the supply of new graduates with training in S&E. This indicator is used as a broad educational category. According to the average value of the indicator S&E graduates, three groups of countries differ in progress across EU. The first group represents countries with higher values than EU average with the "European tiger" Ireland standing out with over 90% more graduates in S&E than the EU average. France, the United Kingdom and Finland follow. Finland and Ireland's economic successes have often been attributed to the countries' devotion to university education. Nonetheless, one of the biggest and most successful European economies, Germany, has a lower value than the EU average.

*Figure 1 Science and engineering graduates**



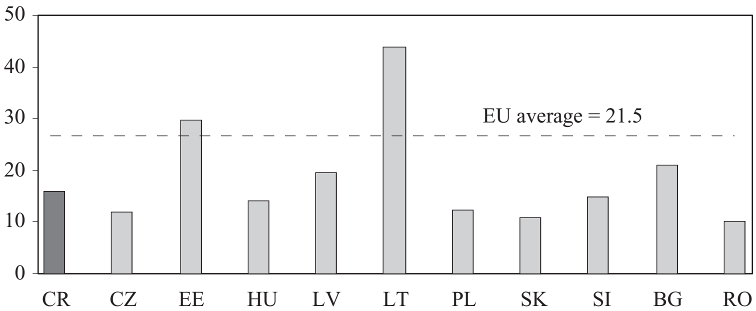
** % of 20-29 years age class*
Source: European Innovation Scoreboard, authors' calculation, based on CBS (2003)

All of the CEEC except Lithuania have fewer S&E graduates than the EU average. The value of the Croatian indicator is slightly lower than the EU average, and places the country in line with Belgium and Germany, which belong to the lower value group. Croatia is leading, with Lithuania, among CEEC.

Population with tertiary education indicator represents a general indicator of the supply of advanced skills (European Commission, 2003:8). On average, 21% of population in the EU has completed a university program. Finland and the UK again stand out as countries with even higher shares of the population with a university degree, implying that their educational systems produce a large advanced-skills base for industries.

The position of Croatia compared to the EU average shows an unfavorable situation because only 15.9% of population has tertiary-level education, which is 26% lower than the EU average. Lithuania and Estonia have managed to fall into the above-EU average group, while Bulgaria's indicator is near the average.

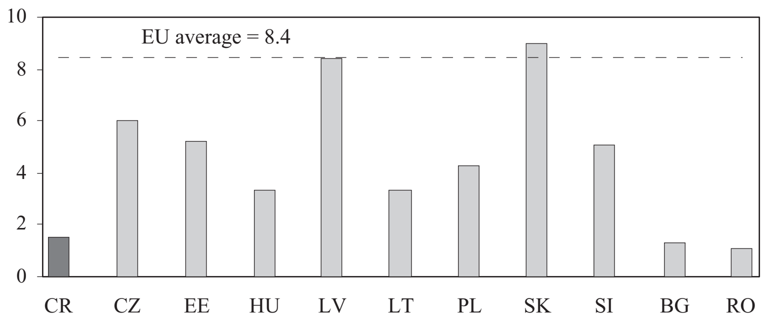
*Figure 2 Population with tertiary education**



** % of 25-64 year age class*
Source: European Innovation Scoreboard, authors' calculation based on CBS (2003)

Life-long learning presents continuous learning of new ideas and skills (European Commission, 2003a:10). The UK (with the Scandinavian countries) manages to lead in the EU with the highest share of participation in life-long learning. Life-long learning presents the most critical problem for Croatia in the human resources category. Not only is the value of this indicator far below the EU average, but is also far below all of the new members' values. The only countries with more critical values are Greece, Bulgaria and Romania – all of which are countries with high rates of unemployment. It appears that education in Croatia is still focused on elementary and secondary education, putting emphasis on outmoded methods and teaching techniques of a narrow range of basic skills (cf. National Competitiveness Council, 2004:21). Also, the links between high education and businesses are underdeveloped, which hinders the accumulation of mutual benefits provided by life-long learning.

*Figure 3 Participation in life-long learning**



** % of 25-64 years age class*

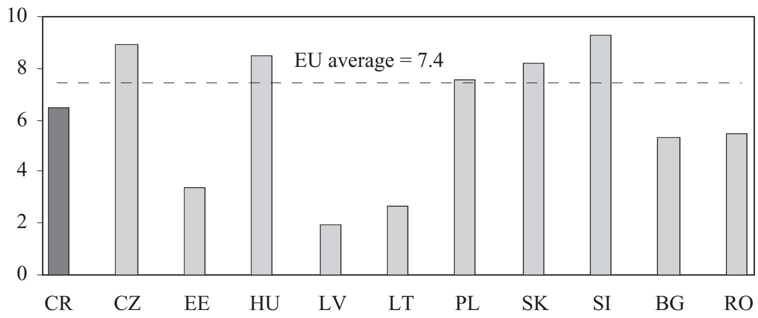
Source: European Innovation Scoreboard, authors' calculation based on CBS (2003)[xi]

If we accept the argument that the level of education quality and participation in life-long learning processes are determinants of national competitiveness (National Competitiveness Council, 2003:54) then the Croatian competitive stance is vulnerable in comparison with EU and other CEE countries.

Employment in medium-high and high technology manufacturing is considered crucial for economic development because it includes sub-sectors with great innovative potential frequently accompanied by business success. In the EU, Germany is the only country with a value higher than the EU average value. The rest of the old members' values are near the average (Finland, Italy, Sweden, etc.). Employment in medium-high technology manufacturing in CEEC is very high and above the EU average in the most progressive new EU members: the Czech Republic, Hungary, Poland, Slovakia and Slovenia. Croatia lags behind these progressive countries, but has a better position than

Bulgaria and Romania. Croatia's indicator value is similar to results obtained from analysis of employment in manufacturing where Croatia had worse results than the Czech Republic, Slovenia and Hungary, but was better off than Bulgaria (Vidovic, 2004: 21). Perhaps this can be explained by the shrinking of the previously strong industrial base in Croatia, while both in Hungary and the Czech Republic this base was strengthened with inflows of export-oriented FDI.

*Figure 4 Employment in medium-high and high technology manufacturing**

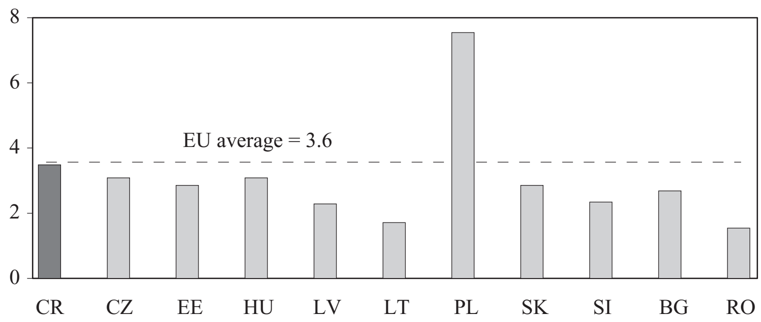


** % of total workforce*
Source: European Innovation Scoreboard, authors' calculation based on CBS (2003)

The importance of the *employment in high-tech services* indicator lies in fact that high technology services both provide services directly to consumers such as telecommunications and provide inputs to the innovative activities of other firms in all sectors of the economy (European Commission, 2004a:11). Employment in medium-high tech industries and services also indicates the potential for catching-up, which is easier if economies are specialized in technology-intensive sectors (Radosevic, 2003b:9).

Interestingly, countries that push the EU average up are mostly smaller countries, and not surprisingly some of them have been shown to have a large base of S&E education; among them are the Scandinavian countries, the Netherlands and Ireland. This indicator is one of those where the CEEC seem to be catching up with the EU or faring well generally. Poland in that respect is leading in the share of population employed in the high-tech service sector. All other CEEC are lagging behind the EU average, Croatia being close to that average with 6.4% of employed in medium-high and high technology manufacturing.

*Figure 5 Employment in high-tech services**



** % of total workforce*
Source: European Innovation Scoreboard, authors' calculation based on CBS (2003)

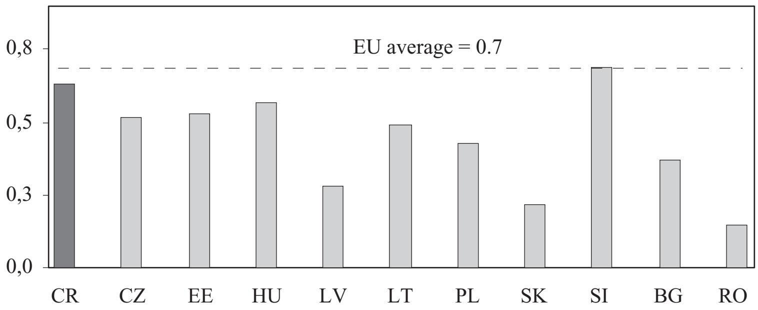
Knowledge creation

According to the values of indicators falling into this category, CEEC are not competitive with the EU in knowledge creation. Croatia ranks unfavorably in all of the indicators, and has not managed to reach the EU average in any of the indicators.

Public R&D expenditures indicator is calculated as the difference between Government Expenditures on Research and Development (GERD) and Business Expenditures on Research and Development (BERD). Its great importance lies in fact that public R&D represents the foundation of every national scientific system and national innovation system. Systems of innovation in the modern sense are made up of interaction between the R&D system, firms and the government.

Slovenia as the credited frontrunner among CEEC has succeeded in getting its expenditures to reach 0.7% of GDP, which is the EU average. Generally, Slovenia takes the lead in all of the indicators in the category of knowledge creation, thereby manifesting the convergence with the EU it has achieved in this respect. Croatia slightly lags behind Slovenia in public expenditures on R&D as percentage of GDP, but is far ahead of the other CEEC and only 8.7% below the EU average.

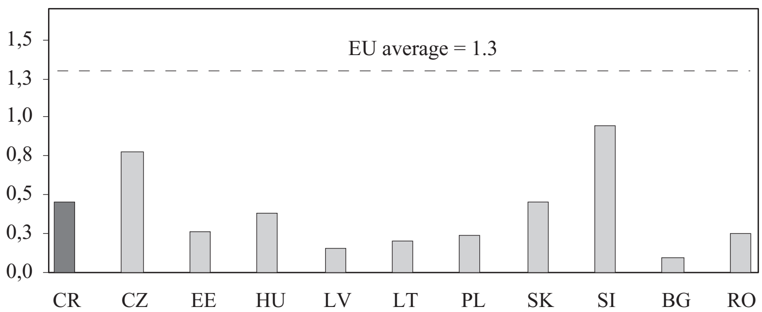
Figure 6 Public research and development expenditures (% GDP)



Source: European Innovation Scoreboard, authors' calculation based on CBS (2003)

Business expenditures on R&D indicator captures the formal creation of new knowledge within firms. It is particularly important in science-based sectors (pharmaceuticals, chemicals and some area of electronics) where most new knowledge is created in or near R&D laboratories (European Commission, 2003a:18). Again, Finland and Sweden take the lead and are the countries where firms spend the most on R&D. Taking into consideration that private sector development is still taking place in CEEC, the low values of the indicator for CEEC are not unexpected. Although Croatia ranks well among CEEC, its position in comparison to the EU average is disadvantageous.

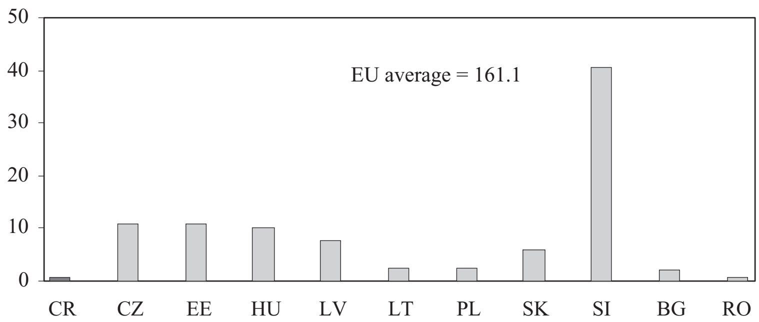
Figure 7 Business expenditures on research and development (% GDP)



Source: European Innovation Scoreboard, authors' calculation based on CBS (2003)

EPO applications indicator covers all applications at the EPO (European Commission, 2003a:24).[xii] The analysis of EPO applications shows that all CEEC values are significantly lower than EU average value. Slovenia, with the highest number of applications is still only 74.7% of the EU average. The public notion of the number of patents and success achieved in their application in Croatia is more favorable, thanks to the intense promotion in the media, than its real position in international terms. This is visible in the low application of those innovations according to EPO standards. The value of this indicator for Croatia is critical, placing the country at the end of the CEEC and making it the least competitive country in that respect. There are two reasons behind Croatia's unfavorable position in EPO statistics. The first one is the low share of legal entities in patent applications at the national level. Legal entities in the 1992-2002 period filed only 12% of total patent applications, while the rest were filed by natural persons (SIPO, 2003). Despite the high share of public expenditure on R&D in Croatia, its BERD is low (0.45% of GDP in 2002), while in Slovenia, which also has a high level of public expenditure on R&D, BERD is more than double that of Croatia (0.94% of GDP in 2002). The second reason is the lack of financial provisions for the breakthrough of Croatian patents into the international market, especially through EPO.

*Figure 8 European Patent Office applications**



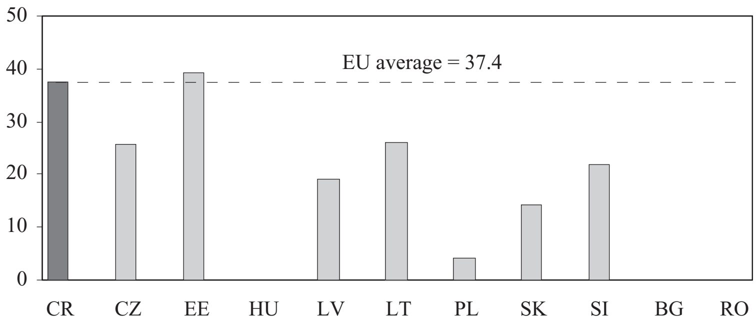
** per million population*
Source: European Innovation Scoreboard, estimation (Croatian Patent Office)

Transmission and application of new knowledge

The overall performance of CEEC indicators in the category of transmission and application of knowledge can not be characterized as successful or unsuccessful.[xiii] It is the individual performance of countries that marks the stance of CEEC in this category and it is not the frontrunners that necessarily deliver the best results. Croatia ranks fairly well in this category relative to both EU average and the CEEC values.

SMEs innovating in-house indicator measures the degree to which manufacturing/services SMEs that have introduced any new or improved products or production processes, have innovated in-house (European Commission, 2003a:28). Only Croatia and Estonia exceed the EU average of SMEs innovating in-house. Croatia's indicator value places the country in line with Austria, Portugal and Sweden.[xiv] The high value of the indicator for Croatia can perhaps be explained by the fact that new investment is by definition any investment into a new product, i.e., a product that is new to the domestic firm. This innovation may, however, be a product that is new to the firm and has actually been introduced via imports.

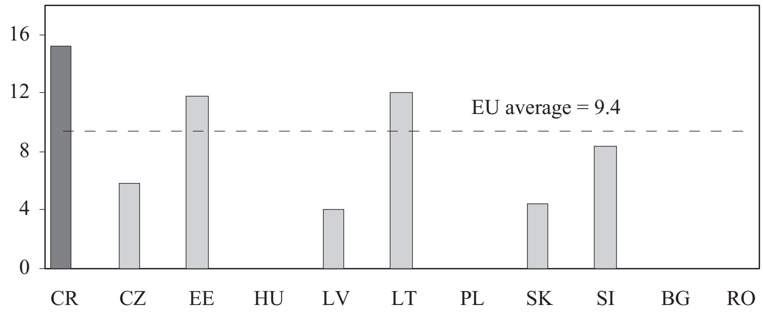
*Figure 9 Small and medium-sized enterprises innovating in-house**



** % of manufacturing/services SMEs*
Source: European Innovation Scoreboard, authors' calculation based on CIS (2004)

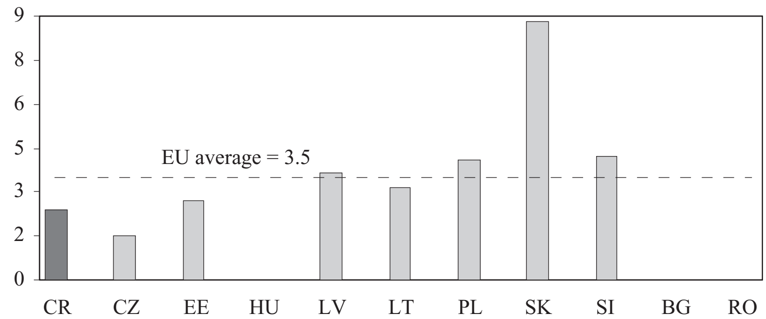
SMEs involved in innovation co-operation indicator measures the degree to which manufacturing SMEs are involved in innovation co-operation. This indicator measures the flow of knowledge between public research institutions and firms and between a firm and other firms (EC, 2003a:30). Manufacturing and services enterprises are most frequently involved in innovation co-operation in the Scandinavian countries. This also seems to be the case in Croatia, which among CEEC has the highest value of the indicator – about the same as Sweden. Explanation of this surprising result may lie in the fact that Croatia had a substantial manufacturing tradition (Vidovic, 2004:6).

*Figure 10 Small and medium-sized enterprises involved in innovation co-operation**



** % of manufacturing/services SMEs*
Source: European Innovation Scoreboard, authors' calculation based on CIS (2004)

*Figure 11 Innovation expenditure**



** % of all turnover in manufacturing/services*
Source: European Innovation Scoreboard, authors' calculation based on CIS (2004)

Innovation expenditures indicator measures total innovation expenditure as a percentage of total turnover in manufacturing and services (European Commission, 2003a:32).[xv] Some CEEC have managed to surpass the average EU value in this indicator. Most pronouncedly, this is the case with the Slovak Republic, the value of whose indicator exceeds the EU average by 55%. Croatia's stance in this respect is quite unfavorable as the country ranks at the end of CEEC.

CONCLUSIONS AND RECOMMENDATIONS

The goal of our paper was to evaluate the state of Croatia's innovation capability in the light of integration into the EU. Croatia has not made any significant progress in its innovation potential and policy with respect to the EU, but by European standards ranks well in comparison to other CEEC, in particular Bulgaria and Romania.

The country's stance in some aspects of human resources development only appears encouraging. For example, the share of S&E graduates of the 20-29 year age class is high, but in fact only reflects the orientation of the Croatian educational system and not the quality. However, another important aspect of the development of human resources – life-long learning – is totally neglected and places Croatia at the end of CEEC and EU rankings. The absence of any links of cooperation between universities and the business sector could be a reason behind this. Therefore, greater attention should be paid to the inclusion of principles of life-long learning into the educational system, which is also promoted by NCC. Promotion of life-long learning, in particular, among the vulnerable groups in population (the unemployed), could also help achieve a better match between labor supply and demand for labor.

Also, the links between the vast national R&D base and educational system and businesses need to be reestablished and promoted. Knowledge will have to be applied and used commercially more in the future, as opposed to the present state in which there is no incentive to turn to the market. A transformed market-oriented research and educational system will be forced to monitor the signals from the market and improve its capacity to supply innovation. However, shock-therapy which would leave the national university and research system to dependence on the market entirely is not a desirable approach in this matter. It would result in a shift from one extreme to another – from emphasis on fundamental research to emphasis on applied research. In that case international excellence and success of the institutions may be publicly acknowledged and ranked.

While the high-tech services sector appears relatively developed in Croatia, the high-tech manufacturing sector appears underdeveloped.

Knowledge creation is an area where policies have obviously failed – business expenditures on R&D are insufficient, which can also explain why EPO applications by Croatian residents are the lowest in CEEC. At the moment, most of patents at the national level are registered by individuals (88%) while the trend is the opposite in the EU, most new patents being registered by the business sector.

Croatia will have to make stronger efforts in innovation policy implementation, but also in coordination with other areas of economic policy – in particular, science and technology policy, SMEs policy and industrial policy. All of these policies must complement each other in facilitating improvement in innovative output. Small economies must nurture the development of small firms and moreover – concomitantly with science and technology policy – strengthen industrial and research centers and technological centers so that the innovation process has more chance to take place.

In the end we could recommend the following.

Goals and targets of an innovation policy should be set explicitly. Croatia must, one the one hand, converge with the EU, and on the other hand, prioritize its own economic development. Innovation policy can serve as a tool to achieve both goals. According to the EU model, the goals and targets of the policy should be set explicitly. Croatia's political commitment to integrate with the EU carries an obligation to come up with a National Development Plan (NDP) before integration. That opportunity can be used to prioritize the development of innovation potential and the implementation of innovation policy. The Office for the Development Strategy has already been considering innovation policy as an integral part of the NDP and should therefore be responsible for designing innovation policy targets. Those plans should be compatible with those already carried out by the ministries responsible for innovation and enterprises: the Ministries of Economy, Science, Education and Sports, and of Finance.

Stronger implementation of programs in the field of innovation policy is called for. Innovation policy needs to coordinate complementary activities in the technological sphere and the potential stakeholders must be aware of the existence and the benefits of those activities. Programs in the field of innovation policy like HITRA were well envisaged, but their implementation was weak due to insufficient coordination between the government, universities and businesses. Such a situation could not have led to stronger political pressure and wider recognition of the importance of the innovation policy. The existing programs need to be implemented more strongly and control mechanisms need to be improved, which would bring wider social benefits. Such a change would result in wider public attention and acknowledgement of the innovation policy.

Obstacles to financial instruments for financing innovations should be removed and access to them eased. Investment into business R&D may be given incentives to grow through increased access to financial instruments especially through non-loan forms of financing such as venture capital. A quantitative goal may be set to correspond to the goals of the EU in this policy field: for investments into R&D sector to reach 3% of GDP in a reasonable period of time. The EU stipulates that most of that investment should come from the private sector. An alternative route to reaching that goal should be the widening of R&D subsidy base to include enterprises. The application of Croatian patents at the European level (EPO) is extremely low. This unfavorable situation may be changed though promotion of patenting in firms via financial provisions provided by the government. The financial planning of subsidies should be carried out by the Ministry of Finance. The culture of business innovation can be rewarded in this way. In order to achieve this, a broad definition of innovation is most wanted.

A statistical base for following-up effects of innovation policy measures and instruments should be set up. Innovation policy requires tuning and adapting to the market. Setting up a statistical base for following-up effects of innovation policy measures and instruments is a necessity. It would enable assessment, monitoring and evaluation of innovation policy and innovation potential. Two frameworks may be used for that purpose. The first one is CIS, as a wide business survey that may be carried out bi-annually. The survey should encompass innovation activity of both SME and big firms, and should enable the evaluation of the effects of innovation policy measures on business innovation potential and output. The Ministry of Science, Education and Sport should be the body responsible for carrying out CIS. Additionally, in the light of the integration with the EU, EIS may be tracked as a system of indicators that allows the ranking of Croatia with the EU and Bulgaria and Romania each year. The Office for the Development Strategy of the Government could keep track of the data within the system of indicators and report on the progress to the Government and the public.

Venture capital should be encouraged. Attention must be devoted to venture capital development since venture capital is one of main sources of finance in the world, and especially so for SME innovators. In Croatia, venture capital is still not presented in the form of a legislated entity but in business practice little of it exists. The Ministry of Finance should propose to Parliament that legislation be introduced concerning venture capital as a new type of business activity.

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i *These changes are defined by the Strategy of Development of Science of the Republic of Croatia in the 21st Century (www.hrvatska21.hr) and the Act on Scientific Activity and Higher Education.*

ii *In the abbreviation AK, A symbolizes the constant that implies the existence of a linear relationship between the national product (Y) and capital (K).*

iii *The Diamond is made of four areas, each of which creates a setting for the prospering of certain industries. These four areas are: (1) factor conditions, (2) demand conditions, (3) related and supporting industries, and (4) firm strategy, structure and rivalry.*

iv *Ministry of Science, Education and Sports since 2004.*

v *Triple Helix means the transformation of science into economic good and promotes intensification of this process. The intensification of those processes increase reliance of industry on knowledge originated in academic institutions (Etzkowitz, 1998).*

vi *Knowledge creation in the post-industrial era is the result of individual or group innovation activity intra/inter firm.*

vii *European Patent Office is a result of unique initiative to establish uniform patent system in Europe, retrieved at [http://www.european-patent-office.org/epo_general.htm].*

viii *The methodological basis of CIS is provided by the Oslo Manual – international source of guidelines for the collection and use of data on innovation activities in industry (OECD, 2003).*

ix *CIS analysis does not include several goods and services sections and subsections from National Classification of Economic Activities (NACE). Those are: Construction, Hotels and Restaurants, Real estate activities, Renting of machinery and equipment without operator and of personal and household goods.*

x *According to technological level economic activities are classified: High-technology (Aerospace, Computers, office machinery, Electronics-communications, Pharmaceuticals); Medium-high-technology (Scientific instruments, Motor vehicles, Electrical machinery, Chemicals, Other transport equipment, Non-electrical machinery); Medium-low-technology (Rubber and plastic products, Shipbuilding, Other manufacturing, Non-ferrous metals, Non-metallic mineral products, Fabricated metal products, Petroleum refining, Ferrous metals); Low-technology (Paper printing, Textile and clothing, Food, beverages, and tobacco, Wood and furniture).*

xi *Croatian CBS provides life-long learning data by carrying out Labour Force Survey twice a year. The value for the first half of 2003 was 34,865 and for the second half of the year 46,610. The nominator value for life-long learning indicator presents yearly average approximations.*

xii *EIS proposed four patent applications indicators: EPO applications, USPTO applications, EPO high-tech patent applications, USPTO high-tech patent applications. Since Croatia has only 2-3 EPO applications per year, it is unnecessary to evaluate other indicators.*

xiii Data for Hungary, Romania and Bulgaria were not available.

xiv Data for Croatia refer to the period 2001-2003 and for the other CEEC countries to the period 1998-2000.

xv Innovation expenditure includes a full range of innovation activities: in-house R&D, extramural R&D, machinery and equipment linked to product and process innovation, spending to acquire patents and licenses, industrial design, training, and the marketing of innovations (European Commission, 2003a).

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