

The IPTS REPORT

EDITED BY THE INSTITUTE FOR PROSPECTIVE TECHNOLOGICAL STUDIES (IPTS)
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A B O U T T H E I P T S R E P O R T

The IPTS Report is produced on a monthly basis - ten issues a year to be precise, since there are no issues in January and August - by the Institute for Prospective Technological Studies (IPTS) of the Joint Research Centre (JRC) of the European Commission. The IPTS formally collaborates in the production of the IPTS Report with a group of prestigious European institutions, forming with IPTS the European Science and Technology Observatory (ESTO). It also benefits from contributions from other colleagues in the JRC.

The Report is produced simultaneously in four languages (English, French, German and Spanish) by the IPTS. The fact that it is not only available in several languages, but also largely prepared and produced on the Internet's World Wide Web, makes it quite an uncommon undertaking.

The Report publishes articles in numerous areas, maintaining a rough balance between them, and exploiting interdisciplinarity as far as possible. Articles are deemed prospectively relevant if they attempt to explore issues not yet on the policymaker's agenda (but projected to be there sooner or later), or underappreciated aspects of issues already on the policymaker's agenda. The multi-stage drafting and redrafting process, based on a series of interactive consultations with outside experts guarantees quality control.

The first, and possibly most significant indicator, of success is that the Report is being read. The issue 00 (December 1995) had a print run of 2000 copies, in what seemed an optimistic projection at the time. Since then, readership of the paper and electronic versions has far exceeded the 10,000 mark. Feedback, requests for subscriptions, as well as contributions, have come from policymaking (but also academic and private sector) circles not only from various parts of Europe but also from the US, Japan, Australia, Latin America, N. Africa, etc.

We shall continue to endeavour to find the best way of fulfilling the expectations of our quite diverse readership, avoiding oversimplification, as well as encyclopaedic reviews and the inaccessibility of academic journals. The key is to remind ourselves, as well as the readers, that we cannot be all things to all people, that it is important to carve our niche and continue optimally exploring and exploiting it, hoping to illuminate topics under a new, revealing light for the benefit of the readers, in order to prepare them for managing the challenges ahead.



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Methods and Foresight**2 The Futures Project: An Overview by the Director of the IPTS****Information and Communication Technology****6 More Efficient E-payment Systems will induce E-commerce Growth**

E-commerce is reliant on the availability of cost-effective and secure payment systems. The Internet has opened up new technical possibilities to make such systems cheaper and more flexible. However, the issues raised are complex and a diverse range of actors are involved.

14 The Impact of Information Technologies on the Stability of International Financial Markets

Information technology is a powerful driver of globalization, particularly in financial markets. And one of the most prominent changes being brought about by this process is increased volatility. A number of policy measures have been put forward to improve the stability of international financial markets.

Innovation and Technology Policy**23 The Impact of Corporate Spin-offs on Competitiveness and Employment in the EU**

There is evidence that by drawing on experience and relationships from their parent companies, spin-offs can often outperform other new start-ups in terms of innovation and job creation. However, not all frameworks are favourable to this type of new firm.

Regional Development**30 Access to Publicly-Funded RTD programmes: EU Government Measures**

SMEs come up against a number of obstacles to participation in publicly funded RTD programmes. Thus, given SMEs importance in the economy, studying ways of overcoming these difficulties is a worthwhile undertaking.

The Futures Project: An Overview by the Director of the IPTS

Dr. Jean-Marie Cadiou, *Director of the IPTS*

The next ten years may well turn out to be the fastest changing years for Europe in its history during peace-time. Information and Communication Technologies are developing at a ferocious pace. Together with breakthroughs in Life Sciences, these technologies are transforming the way we live and the way we work, while the single currency, the enlargement of the EU, demographic changes, sustainability concerns and the wider context of globalisation are transforming our economy. Each of these "trend breaks" is in itself a challenge. The fact that they will occur simultaneously over the next ten years, and strongly interact with each other, is even more challenging for most policy areas and in particular policies relating to technology, competitiveness and employment.

Many new opportunities for growth and for satisfying human needs will derive from the breakthroughs that will transform the technological frontier, especially in the areas of Information and Communication Technologies (ICTs) and Biotechnologies. But the key technological drivers also bring challenges. First, these technologies are carriers of globalisation. They raise global governance issues (for example over privacy and security in e-commerce and on food policy regarding genetically modified organisms). Second, the lead companies are multinationals. Their technologies and the global

orientation of their actions are transforming the rules of the game on competitiveness: new markets are opening up, strategic acquisitions are being made and alliances formed. The pace of change brings increasing uncertainty. Third, people and firms will need new skills and competencies to use and work with these new technologies effectively.

Europe though is not just a passive rider on a wave of new technologies and globalisation. Some of the most dramatic changes that are on the agenda for the next ten years have been put there by European decisions. The Single Market will be fully functional - forming the largest block of consumer demand in the World. The Euro will be in circulation - helping to consolidate the reality of the single economic space of Europe. Enlargement will be underway, extending the scale of the European Union and strengthening its economic and social ties with the surrounding countries, to form the key economic pole of the world economy. Europe clearly has the potential to become the lead actor on the global stage.

Meanwhile, the evolution of European Society itself will be far from slow. Perhaps the key underlying societal trend is the ageing of the European population. This is especially significant at a time of almost permanent technological and industrial revolution that is tending to undermine

the relevance of existing skills and occupational structures. Renewing skills rather than replacing the workers will call for responses from all sides: individuals, employers as well as the State.

Also, over the long term there have been steady changes in lifestyles and family structures such as increasing numbers of working women, rising educational levels, increasing single person or single parent families and rising divorce rates. This changing social scene interacts with shifts in the structures of employment (increased part-time work, the demise of the "job for life", shortening skill cycles, the blurring of home-work boundaries, growing telework and freelancing). The result is a "Mosaic Society" in which the well-defined categories that the post-war institutions and social mechanisms were designed to support no longer fit people and their aspirations and needs. Here too there will be need for changes in social systems. The changes required, however, will vary according to existing national structures because Europe is very different from place to place, with different problems and ways forward.

The IPTS "Futures" Project was launched in mid-1998 precisely to examine the individual and combined effects of these technological, economic, political and social drivers. Especially, "Futures" set out to find out what they mean for technology, competitiveness and employment. Over the past 18 months, "Futures" has been the major horizontal activity of the Institute for Prospective Technological Studies (one of the eight institutes of the European Commission's Joint Research Centre). In the process IPTS brought together more than 150 experts and policy-makers, drawn from industry, academia and government to take part in a series of brainstorming sessions, seminars and workshops. A series of 17 reports have so far been published. The result is a major benchmarking and prospective analysis carried out at full European scale.

The first of the key messages to emerge from the Futures Project was the way in which the *technological dynamo* is today driving forward innovation and change with an unprecedented momentum. Clearly, Europe has to maintain its position in the technological vanguard. But can it? It has many areas of strength, but also weaknesses and worrying gaps in its technological capabilities. Particularly, there are gaps in some of the underlying enabling technologies that will underpin the high-technology industries of the future. Europe has many options, but must also work towards a world class system of incentives, infrastructures and investments for research and development. And above all, it must take advantage of the European dimension, and fully realise the potential of its natural "European Research Area". Also, if the innovation system operates too slowly, lacks sufficient scale and integration or, perhaps worst of all, focuses on the wrong targets, Europe will not punch its weight in the 21st century.

The second main theme of the report to emerge was the position of *Europe in the Global Knowledge Society*, in particular in relation to globalisation, competitiveness and know-how. The technological changes described above operate to drive and to carry forward globalisation, and this has direct impacts on competitiveness. Perhaps the clearest manifestations of globalisation are the worldwide alliances between large multinationals and increasing pressures for systems of governance to make sure that these overarching economic forces operate for the benefit of the many rather than the few. Many voices, however, express strongly different views and it is hard to reconcile these interests in complex areas such as carbon-dioxide abatement, privacy and security on the Internet and control of GMOs. Economic globalisation, in fact, very firmly puts global governance on the agenda for the coming years, not just for the

encouragement of economic interests and growth but for the protection of people and their interests. Europe's growing size and wealth give it a legitimate claim in the global arena, to promote its economic interests and those of its people. However, recent experiences with international co-ordination authorities underline that the search for workable formulas that transcend vested local or national interests will constitute a particularly difficult challenge for policy in the coming years.

At firm level, globalisation involves juggling with, and restructuring, economic assets from place to place, with capital investments becoming increasingly footloose. Such global changes often have rapid and dramatic consequences at local level, in terms of both inward investment and divestment. Meanwhile, the governance institutions of the world economy are still largely organised at national level while markets are largely regional. This mismatch of scales between drivers and responses is being tackled at the European level by the implementation of the single market and monetary union. Europe can already claim to be the largest consumer market in the world, which is certainly a key factor in attracting investment and jobs. So far the full benefits in terms of greater economies of scale have not been fully realised, but when they do they should have considerable implications for Europe's global competitiveness, particularly if the extra scale effects of enlargement can be mobilised.

One key message that has emerged is that the competitiveness of regions rests crucially on whether they are attractive places to invest, to do business and to live and work. In the global economy more and more of the attractiveness of a region lies in the knowledge assets it can mobilise. Such knowledge is often embedded in very tangible things like hardware, technologies and equipment. Knowledge exists in fixed

intangibles such as patents, software and copyrights. Knowledge lies also in human systems such as university departments, research laboratories and high performance organisations. Unlocking this knowledge, however, requires a further form of knowledge: know-how - i.e. the right people with the right skills and attitudes. This could be a European strength in the global economy, because Europe has good basic innovation systems and well-educated people. But are Europeans educated in the right skills? Are Europeans innovative enough to respond to the challenges that have been outlined above? Indeed, are European institutions well suited to this age of innovation? Many times during the Futures Project we encountered a concern that European Society is *not yet* well equipped for the challenges of technology and the global society.

The final main theme to emerge was the way that *European Society is driving change*. Here we saw the challenges of the simultaneous ageing of society and the emergence of "Mosaic Living". In particular, we looked at the major challenges that Europe will have to confront in adapting its social systems to the "shock of the new" as well as to the long-term trends towards ageing. In particular, the difficulty of renewing skills points towards the likelihood of a serious mismatch between what is technologically possible and what is socially accepted. This issue also raises the spectre of a multipolarised society in Europe, with the traditional divisions between rich and poor, and core and periphery being supplemented by new axes of social separation such as "information haves" and "have nots", work rich and work poor, or well-off elderly retired versus those that are on basic incomes. These strains and divisions will be particularly acute in the case of the pre-accession countries, which will have to make up for a legacy of under-investment in infrastructures and institutions. Somehow, the new partners of the EU will have to make fast economic gains without

abandoning social cohesion. And the many European Societies that will make up the new Union will have to meld into a society that has sufficient legitimacy amongst its people to carry the European vision forward through current and further phases of enlargement.

While not aiming to address the full spectrum of social and economic issues, the Futures Project has identified some of the main changes confronting Europe in the coming decade. Unique opportunities are opening up for Europe, but it also faces challenges of historic size and

significance: to harness the technological dynamo; to take a lead in the global knowledge society; to build a sustainable and inclusive Enlarged Europe for the 21st Century.

This will call for timely and well designed incentives to invest in infrastructures and innovation. Especially important will be investments that actively engage more Europeans, of all ages, than we do today. More than ever, people will be the key to unlock the way to Europe as a knowledgeable society as it moves along the road to 2010.

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More Efficient E-payment Systems will induce E-commerce Growth

Ioannis Maghiros and Duncan Gilson, *IPTS*

Issue: The success of e-commerce depends on the availability of low-cost, reliable and secure payment systems. There has to date been a two-way interaction between the payment systems available for e-commerce and the characteristics of the markets for the goods and services available. Thus the types of payment systems available in the future are likely to have a similar shaping effect on the e-commerce landscape, within a context of both evolving content and access technologies.

Relevance: A number of rapidly evolving factors, such as the interoperability of cross-border systems, and the emergence of mobile-phone-based Internet access, non-PC end-user terminals and micro-payment systems are likely to influence the evolution of e-commerce in the medium term. For new e-payment systems to be successfully implemented, all interested parties need to discuss thoroughly their socio-economic implications, if fragmentation, non-interoperability and lack of consumer confidence are to be avoided.

Payment systems are the common denominator of all e-commerce, and are likely to encourage convergence between sectors

Introduction

The growth of electronic commerce (e-commerce) is dependent, among other factors, on the existence of secure, user-friendly and cost-effective payment systems. Handling payments is a costly process that has been a central part of bank business for the past century. However, it is now being transformed by technological developments, and in particular the Internet. The importance of the payment function lies in the fact that it could encourage convergence between sectors with disparate objectives, since payment systems are the common denominator of all other e-commerce systems. Conceptually, the alternative means of payment available for e-

commerce may be classified as either electronic money (e-money), or electronic access products. The difference between them is that whereas electronic access products basically provide Internet access to traditional products (credit card payments, bank transfers, etc.), e-money is a new concept, and in particular is considered to be "private money not depending on central bank reserves" (The Economist, 22 Jan. 2000).

Consolidated methods of payment, already used for distance selling mostly at national level, such as cheque, cash-on-delivery and credit-transfer mechanisms, have proven easy to adapt to electronic transactions. The credit card system has to date been the usual payments instrument

for goods ordered over the Internet in both Europe and the US. This is despite security concerns and relatively high transaction costs. Nevertheless, the lack of a widely accepted e-payment system is not considered to be a major barrier to the uptake of e-commerce overall (IPTS study, 1999). The most important factors are undoubtedly user trust and confidence, and the low perceived value added of the e-commerce applications (for instance, in terms of convenience of use, cultural and linguistic barriers -most sites being in English). Also, as a theoretical upper limit on growth, PC penetration rates are significant.

Apart from credit cards, the main actual or potential means of making electronic payments are:

- debit cards (not yet as internationally interoperable as credit cards);
- electronic purses (i.e. smart cards which either store a value or hold a record of a balance on an account; may be re-loadable and /or disposable or even contactless for certain applications);
- adding small values to phone bills or ISP bills (trusted billing intermediary);
- electronic cheques (relying on digital signatures and authentication techniques);
- agencies which take credit card payments and make payments into individual bank accounts;
- mobile-phone-based payment-systems.

Credit cards as an e-payment systems

Without doubt, the main means of payment used to date for consumer transactions initiated via the Internet is the credit card. Credit cards have proved popular for a number of reasons:

- the system is familiar to users and was widely used before the advent of e-commerce, thus bolstering user confidence;
- transaction costs are hidden from users (i.e. basically met by sellers, and passed on to all customers, not just credit card users);
- payment is simple anywhere and in any currency, thus matching the global reach of the Internet;
- the credit-issuing company shares the transaction risk, helping overcome consumers' reluctance to buy goods they have not actually seen from sellers they may not know (in the physical world this function was important because it enabled sellers to take payment from buyers they did not know; on-line this trust relationship is needed in both directions).

Credit cards, though, are not without their disadvantages. Firstly, the relatively high transaction cost makes them impractical for small-value payments, in which case subscriptions or advertising tend to be resorted to as a means of covering costs (the need for a micro-payment infrastructure is argued more fully in Rader, *et al.* 2000). Secondly, they cannot be used directly for individuals to make payments to other individuals (peer-to-peer transactions). Thirdly, protecting the security of transactions is vital, especially in the virtual world where there is no payment guarantee to the merchant by a bank (Internet transactions are dealt with just like mail order/telephone order transactions). In most cases the cost of fraud falls largely upon the card issuer (depending on the legal framework in the country in question), so card issuing companies have a strong stake in ensuring reliable security.

Users' fears about security issues seem to be a consequence of the newness and relative

A number of payment alternatives already exist for e-commerce, but credit cards have so far proven to be the most popular. This is largely due to the confidence users already had in the system before using their cards for e-commerce

The disadvantages of credit cards for e-commerce include the fact that they cannot be used directly for small value payments or peer-to-peer transactions

From the security point of view, the main danger with using credit cards on-line is not interception but authentication.

Initiatives are underway to tackle this issue, and as it is the credit card companies that pay most of the cost of fraud, it is likely that effective solutions will be put in place

unfamiliarity of the medium rather than real risks inherent in the system. Secure servers using SSL to encrypt card details as they are sent back and forth provide a level of security at least equivalent to traditional means of card use. What has proven to be a problem from the security point of view is not interception but authentication. Some of the most serious cases of on-line fraud seem to have involved the use of details of cards used in traditional ways (e.g. payments slips collected from among paper waste) although card details stored in on-line databases are potentially at risk, as news of a heist of thousands of credit cards from the CD Universe Web site has shown (MSNBC, March 2000). Having, collected card numbers, by whatever means, fraudsters then exploit the anonymity of the Internet to use the details to make untraceable purchases (when making cross-border purchases, they may be further aided by the fact that the address-verification system used by merchants to compare billing and delivery information in the U.S. is useless overseas). In response to this threat, credit issuing companies are planning to implement measures such as the use of smart-cards to improve authentication (El Pais, January 2000). Also, in the US, Visa and MasterCard and others have joined forces to develop the Secure Electronic Transactions (SET™) standard for online payments; a single technical specification for safeguarding payment card purchases made over open networks. It includes digital signatures and digital certificates for all parties involved: the customer, the merchant, and the financial institution. SET™ combines a range of cryptographic means, using algorithms based on DES (Data Encryption Standard), RSA (the encryption algorithm invented by Rivest, Shamir and Adleman in 1976, which uses different keys for encryption and for decryption) and digital signatures (for more details see the SET website).

In the present scenario, payments are traceable to a particular card, and thus (fraud

notwithstanding) to a particular cardholder. In the virtual environment, where privacy issues of even greater concern may subsequently arise, users may find that, in certain circumstances, they prefer the anonymity they enjoy with cash. This may therefore create demand for anonymous payment products of one type or another (the issue here is to technologically establish a level of anonymity dependent on the nature of the transaction). However, the potential misuses of anonymity (criminal activities, money laundering, tax evasion, etc.) are a major source of concern to the relevant authorities. Moreover, given the fact that e-money may bypass central banks, these are not the only tax and sovereignty issues that certain new e-payment systems may raise (See Kyriakou, 1998).

The diversification of the e-commerce market

E-commerce is best suited to areas of business where the margins are high relative to shipping costs (i.e. light, valuable goods, intangibles and goods transported over short distances), so growth is likely to be fastest in these products and services. The Internet does not respect national boundaries, but so far, cross-border e-commerce has mainly favoured the US, with relatively little trade between individual European countries. Despite this, there has been speculation that the advent of the euro might redress the balance by boosting intra-European e-commerce. However, given the ease with which credit cards can be used across currency areas, common standards of consumer protection might perhaps be a more important factor (IPTS Study, 1999). The fact that the UK and a number of Scandinavian countries seem - according to some indicators - to be ahead of the rest of Europe in their take-up of e-commerce suggests that linguistic and cultural factors are probably more important than a common currency at this stage.

The areas in which growth in cross-border e-commerce is expected are basically those which have been the mainstays of e-commerce so far, such as: (a) intangibles (software, information, music); (b) standardized consumer durables (books in particular); (c) new services in the telecoms and Internet access area; (d) financial services; and (e) airline tickets and other travel services.

Currently available payments systems have already stamped their mark on the shape of e-commerce and are generally adequate for most of the areas listed above, with the exception of information services and music, which could clearly benefit from a micro-payment system. The shape of the e-commerce market will continue to depend on the payment systems underpinning it (i.e. there would be growth in other areas if there were the payment methods available to support them). Shaping forces in the medium term might

include the increased cross-border trade anticipated in the wake of the euro and the rapid growth in intangibles (services, information, music, etc.) traded over the Internet. Whatever the case, any new system would have to compete - directly or indirectly- with the dominant payment systems. For this reason e-purses (see Box 1) are now often placed and distributed on existing credit cards so as to make use of the credit cards' established infrastructure. However, the fact that mobile phones can already provide a number of key ingredients of payment systems (user authentication, billing infrastructure, etc.) makes them look like strong contenders. This is likely to be reinforced by another complementary trend in mobile telephony.

The Internet goes mobile

The biggest wildcard in the e-commerce and e-payment field at the moment is the way mobile

Box 1: Electronic purse schemes in Europe

A number of e-purse schemes in Europe have already gone far beyond the pilot stage. These include the Chipknip and the Chipper re-loadable e-purse systems in the Netherlands, the GeldKarte re-loadable e-purse systems in Germany, the Danmønt disposable e-purse system in Denmark, the Avant e-purse system (available in both disposable and re-loadable forms) in Finland. There are also similar e-purse systems in Spain, Austria, Sweden, Italy and Belgium.

None of these systems are compatible (although the Dutch, German and Italian e-purse systems have confirmed their intention to become interoperable. In this respect, the work of the European Committee for Banking Standards (ECBS Technical Report 102 on "Overview of European Electronic Purse Projects") has led to the concept of a multi-currency European Electronic Purse. The Common Electronic Purse Specification (CEPS) group (Europay, Visa International, Proton, ZKA Germany, Sermepa Spain, and American Express) took the next step in achieving consensus (December 1998) towards international interoperability.

It is likely that any future e-purse scheme will appear as one more function on a multi-application card, such as bankcards using the EMV multi-application chip (EMV - Europay International, MasterCard International and Visa International Integrated Circuit Card Specifications for Payment Systems) or GSM enabled device micro-SIM (Subscriber Identity module) cards, or WIM (WAP enabled SIM cards) guaranteeing quick and cost-effective Internet loading of e-money. (Böhle et al., 1999)

The possibility of accessing the Internet from the next generation of mobile phones is likely to have a powerful influence on e-commerce and e-payment systems

The use of the SIM card in the user's mobile phone as part of a payment system implies a shift in the roles of both banks and telephone operators

Internet access develops. Already schemes, such as internet access via SMS (short message service), and pre-paid re-loadable cards, are in place in the UK and Scandinavian countries allowing payment to be made via a mobile phone (*Böhle et al.*, 1999). Two more varieties are also available currently, one adding the cost of a small purchase to the user's phone bill, the other using the SIM card inside each GSM phone (recording and charging for transactions) as a credit card (Le Monde, February 2000). Given that the next generation of mobile phones, which will allow direct Internet access, is already appearing on the horizon, the possibility of combining the browser (albeit a microbrowser) and payment system in the same device seems already to be encouraging potential actors to take up strategic positions. Examples include the deal between the mobile equipment maker Nokia and the leading e-commerce business Amazon.com or the co-operation between Visa and Ericsson to develop secure payment systems using open standards.

Developments in SIM (Subscriber Identity module) memory capacity (currently 64 Kbytes and growing) are bringing closer the feasibility of more sophisticated multi-application uses. Also, the advent of the Wireless Application Protocol (WAP), which will enable the next generation of mobile phones direct access to Internet services, is likely to give a considerable boost to e-commerce (Electronic Telegraph, February 2000) for two main reasons. Firstly, PC penetration rates of around 20-25% place a ceiling on potential growth of the current model, but with mobile phone penetration of up to 65% in some countries of Europe, the potential wireless e-commerce market looks very much bigger. The second reason is that just as mobile phones, rather than simply taking a share of total phone time from the fixed telephone, actually expanded the market by making phone conversations possible at all sorts of times they had not been previously,

it is also conceivable that hand-held Internet devices will do the same for e-commerce. What is more, wireless access also looks as though it may be able to leapfrog fixed-wire telecoms and bring the Internet to users in emerging economies where mobile phones are proving a much faster and more cost-effective way of bringing telecommunications to scattered, largely rural, communities. For instance, within a 5-10 year horizon, mobile access may bring considerable benefits to retail banking by opening up a huge market of new customers in developing rural areas who need access to micro-credit and more productive savings investments (The Financial Times, March 2000).

It is likely that the sort of services initially on offer will be news, weather, stock prices, etc. together with on-line banking and shopping. But, the small screens on mobile phones do not lend themselves to the sort of banner advertising typical on the PC-based Internet, so content providers will no doubt be looking for other ways of raising revenue. Therefore, in the short to medium term, one can envisage a mixture of mobile devices being operational, each satisfying the need for a variety of both internet-based and non-internet information services (recorded information, voice recognition). Also under debate is whether banks will accept the possible diminishing of their role in the relationship with the customer implied by multi-application SIM cards, or whether yet another model that turns dual-slot mobile phones into smart-card readers will prevail (thus enabling payment companies to work with operators while maintaining the direct link to the customer).

The increasing use of wireless devices to access the Internet will just be part of a broader trend towards non-PC access. Television-based Internet has so far been slow to take off, but may eventually do so as e-commerce achieves critical mass. At the same time, Europe has a number of

other contenders that may also make their mark (McMeekin, *et al.*, 2000).

How might e-payment systems evolve?

Creating an environment conducive to translating Europe's lead in mobile telephony into a lead in mobile Internet access would benefit its hardware and software industries (which have shown a lead in this area), and should also bolster its content providers (who are better equipped to provide local content and meet users' needs for linguistic diversity). Additionally, business-to-business processes and handling the integration of invoice and distribution information in e-commerce, represent business opportunities for European enterprises. New e-payment schemes are also being developed. For example SmartAxis which uses the Proton and Mondex e-purses, Passport supported by Microsoft, Market-smarter and Buy-It as well as a new SET implementation by VISA. In general the situation is characterized by doubts about the business model (high infrastructure costs, low margins on transactions, fear of cannibalizing business of existing systems, etc.) as well as the emergence of completely new models (services based on tangible products or third party agglomeration of consumer requests). In addition there are increasing doubts about the alternatives to solving existing technical problems (security, interoperability, and cost concerns).

Security is essential but it imposes costs. If this is not properly managed, a situation could arise in which there is 'unfair' competition from solutions that skimp on security to undercut their more security conscious competitors, which could potentially damage confidence in the market as a whole. Interoperability requires the availability of world-wide infrastructure and therefore imposes the need for early consensus. It is argued that eventually technological (and system) compatibility will emerge, even at the cost of replacing existing

infrastructure. Nevertheless, the case of early adoption of a standard protocol (like GSM), shows that bringing all the interested parties together to discuss a standard approach (albeit on a second generation technological platform) can play an important part in creating markets for all actors.

In this regard, the IPTS has initiated an activity (European electronic payment systems observatory) aimed at establishing a European reference point of excellence that will develop a continuous monitoring and analysis function focused on emerging developments in issues related to e-payment systems, with a view to leading to consensus-building. This will be achieved by setting up and running a Forum of experts and market players (such as banking, credit card and retail sector representatives, technology providers, together with standards bodies, academia, government and consumer-protection experts). The Forum will address strategic and technological issues in e-payment systems from the technical and socio-economic perspectives operating as a set of thematic panels focusing on different priority areas. Of key importance to the success of this activity will be the neutrality, transparency and openness of the collaborating partners in the Forum and its management. The Forum will hold public meetings aimed at defining recommendations for standardizers, regulators, and others. It is the aim of the IPTS in establishing this observatory to aid in the decision-making process at a European level as well as to inform the public at large. Other institutes of the Joint Research Centre are also involved in this field, notably through the work of the IHCP (Institute for Health and Consumer Protection) and ISIS (Institute for Safety, Informatics and Systems) (see the JRC e-commerce cluster website).

Conclusions

As far as e-commerce is concerned, the limitations of the current payment systems, and in

The IPTS has initiated an e-payment systems observatory to address the strategic and technological issues raised by e-payment systems from technical and socio-economic perspectives

As far as e-commerce is concerned, the limitations of the current payment systems, and in particular credit cards, are that they are not generally appropriate for small-value payments or payments between individuals

particular credit cards, are that they are not generally appropriate for small-value payments or payments between individuals (peer-to-peer transactions). There may be scope for charges to come down, as there are often complaints from retailers that their charges are inflated and no longer reflect the true cost of transaction processing or credit risk (Financial Times, September 1999). A move in this direction might make cards more useful for smaller payments than today (but probably never so for micro-payments), but not solve the issue of peer-to-peer transactions. There is, of course, no reason to suppose that the future will not see various means of payment coexisting in e-commerce, the way they currently do in the bricks-and-mortar world.

Moreover, a number of factors are likely to influence the evolution of e-commerce in the medium term. The most important will probably be the growing share of Internet access via mobile and other non-PC terminals, and the kinds of e-payment systems they bring with them. Factors such as interoperability of systems, particularly across borders, and the availability of micro-

payment and peer-to-peer payment systems could also be significant. The availability of alternative means of payment for use both on and off the Internet could play a role both in stimulating more competition in the financial services sector and creating new opportunities for it. Successful implementation of new e-payment systems will have a profound impact on settling payments in the public sector.

A stable legal framework needs to be hammered out, and questions such as (i) when a scheme constitutes issuing money (traditionally the preserve of central banks), (ii) whether non-financial institutions may play a role, and (iii) what safeguards and supervision mechanisms are required. In addition, pan-European standards and protocols (on both technological and strategic-related issues) need to emerge through consensus-building and market-driven processes. However, for this development to take place smoothly, and in a way that does not exacerbate security concerns and create a confusion of conflicting solutions, a systematic information exchange at the European level is needed.

Keywords

e-commerce, e-payment, on-line security, electronic purses, WAP Internet, SIM payments

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The SET website can be found at: <http://www.setco.org> <http://www.smartaxis.com/home/index.html>

SmartAxis is smart card based e-cash for new e-services

<http://www.passport.com/> Microsoft's Passport includes a sign-in service and a wallet service

<http://www.market-smarter.com/accounts.htm/> a one stop guide to creating an online business

<http://buyit.beseen.com/> allows businesses to accept credit card orders online without a merchant account

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The Impact of Information Technologies on the Stability of International Financial Markets

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Issue: Developments in information technologies (IT), in both telecommunications and information processing, have strongly influenced the evolution of world trade, financial services and international capital flows during recent decades. These developments have prompted a debate on the role national and international institutions should play in the new framework of a globalized economy.

Relevance: The current international institutional framework has proven inadequate to deal with the new environment created by the globalization of trade and capital flows. A range of policy options have been put forward for consideration at both European and international levels.

Although the globalization of capital markets allows better possibilities for resource allocation, it also increases the speed at which capital can be withdrawn from an economy

Introduction

In recent years, the increase in demand for financial services and the appearance of new products (especially derivatives) have contributed to driving up the stock of financial assets (shares, bonds, bank deposits), which in developed economies have been growing more than twice as fast as GDP, from US\$12 trillion in 1980 to almost US\$80 trillion in 1999 (BIS, 1999). Market turnover for the group of equity, debt, derivatives and foreign exchange markets has grown even faster.

The growth of capital markets has been accompanied by a tendency towards globalization, which offers both new benefits and new problems. On the one hand, globalization of capital markets

allows better possibilities for resource allocation. On the other hand, global capital markets raise concerns because of the volume of funds involved and the speed at which capital can be withdrawn from an economy (*capital flow reversals*).

The main factors behind the transformation of financial markets are:

- Governments have reduced restrictions on capital flows and eased regulations on financial markets.
- Barriers to trade in goods have been lowered.
- Sectors that used to be strictly controlled, notably telecommunications, have undergone liberalization and are being increasingly opened up to international competition.

- The expectation of high rates of return on investment in developing countries, together with macroeconomic stabilization policies by their governments, have attracted foreign capital.
- Technological developments in the computer and telecommunications industries, and the spread of sophisticated infrastructures, have eliminated many barriers created by physical distance, allowing *virtual* proximity. This has had important consequences for the behaviour of both firms and markets.

The interactions between the different factors have determined the direction of change. For instance, domestic authorities promoted deregulation of capital markets with the aim of raising market efficiency, but were also influenced by the fact that new technologies allowed existing regulations to be circumvented in various ways, for example by making it easier to conduct formerly unauthorized transactions offshore.

Main IT innovations in the financial sector in recent years

Advances in information and telecommunications technologies have changed the structure of the financial system by lowering transaction costs and reducing information asymmetries (Mishkin and Strahan, 1999).

When financial transactions are conducted via electronic channels, their cost is reduced to about one hundredth of the original magnitude. At the same time, the communication and information processing facilities afforded by the new technologies have not only lowered the costs of transactions, but they allow a faster and cheaper spread of information.

Mishkin and Strahan (1999) single out three key changes that the new information technologies have caused in the financial sector: the decreasing role of traditional financial intermediaries in debt markets (improved business financing), the growth of derivatives markets (better possibilities of risk

New information technologies have shrunk the role of traditional financial intermediaries, fostered the growth of the derivatives market and increased the importance of electronic payment systems

Box 1: Internet banking

The Internet is expected to have a major impact on the banking sector. Currently, its market share is still small (only around 3% of European customers perform transactions on-line, according to J.P.Morgan; see Table 1). In spite of this, many established banks are rushing to enter the market, in most cases via alliances with telecommunications companies or other firms that have expertise in the area, such as Internet portals.

Far from being just another distribution channel, the Internet is expected to significantly influence the industry. For instance, the Internet is shifting power from banks to their customers, by allowing them to search for the best price for products. The range of choice is already fairly wide: there are web sites consisting of a search engine for best products/prices, and other sites where the banks offer their own products together with products from competing firms.

With the development of Internet banking, competition is expected to increase in the sector. However the banking industry will not be the only source of competition, but will be accompanied by other financial intermediaries such as insurance companies, and even non-financial firms, such as technology companies that control communications networks and the gateways to them. Such companies could set themselves up as brokers, directing consumers to the most suitable product for them. On the other hand, banks are in turn considering using the Internet to widen the scope of their businesses to include, for instance, shopping via electronic commerce. (See ECB, 1999.)

Table 1. Electronic banking customers as of June 1999

Country	Number of customers	Percent of total
Austria	33,500	2.1
Denmark	260,000	5.8
Finland	610,000	17.4
France	131,125	0.9
Germany	780,000	4.2
Italy	36,500	0.2
Holland	130,000	3.6
Norway	54,000	3.1
Spain	277,059	1.1
Sweden	705,000	6.9
Switzerland	140,000	2.3
EU total (except the UK)	3,162,184	2.8

Source: J.P. Morgan

IT is changing the nature of financial products and allowing them to be unbundled and re-bundled in new ways to match the customer's needs

IT has also brought about a spectacular rise in the volume of cross-border transactions

allocation), and the increasing importance of electronic payment systems (better management of household finances).

The new environment of deregulation and IT developments has had a strong influence on the banking sector (ECB, 1999). In response to the new environment, a consolidation process is under way in many countries. Besides allowing transactions to be conducted more efficiently, technology allows banks to market their products more effectively. For example, banks build up sophisticated databases containing information about their consumers, and through data mining they are then able to target their commercial efforts more precisely, knowing which range of products individual consumers might be interested in buying. Technology also affects the very products that banks sell. For example, technology allows banks to apply credit-scoring techniques to consumer credits, mortgages or credit cards, thereby automating part of the process; in this way, products that used to be highly dependent on the institution's evaluation of its customer, have become more standardized (a process known as *commoditization*). The commoditization of products is also encouraged

further by technology allowing the unbundling and re-bundling of products, and their separate delivery to the customer. Similarly, technology allows these same products –for example a loan to a company– to be traded in capital markets (*securitization*) instead of remaining on the bank's balance sheet.

Effects of IT developments on the evolution of international capital flows during the recent years

Advances in technology have enabled the development of a wide range of financial products that have made markets more efficient. As regards international operations, the composition of international flows has been changing in recent years from the more traditional foreign direct investment and bank lending, towards an increasing share of securities transactions. Table 2 shows the spectacular growth in cross-border transactions in bonds and equities in a number of significant countries. Table 3 shows the (notional) amounts outstanding at year-end in the international markets for selected derivative instruments, including both exchanges and (over-the-counter) OTC markets.

**Table 2. Cross-border transactions in bonds and equities
(as a percentage of GDP)**

	1975	1980	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998
United States	4	9	35	89	96	107	129	131	135	159	213	230
Japan	2	8	62	119	92	72	78	60	65	79	96	91
Germany	5	7	33	57	55	85	170	158	172	200	257	334
France	n/a	5	21	54	79	122	187	197	187	258	314	415
Italy	1	1	4	27	60	92	192	207	253	470	677	640
Canada	3	9	27	65	83	114	153	206	187	251	355	331

*Gross purchases and sales of securities between residents and non-residents.

Source: Bank for International Settlements (BIS), 69th Annual Report, May 1999.

Table 3. Markets for selected financial derivative instruments

	Notional amounts outstanding at year-end (in billions of US dollars)					
	1993	1994	1995	1996	1997	1998
Exchange-traded instruments	7,771.2	8,862.9	9,188.6	9,879.6	12,202.2	13,549.2
Interest rate futures	4,958.8	5,777.6	5,863.4	5,931.2	7,489.2	7,702.2
Interest rate options	2,362.4	2,623.6	2,741.8	3,277.8	3,639.9	4,602.8
Currency futures	34.7	40.1	38.3	50.3	51.9	38.1
Currency options	75.6	55.6	43.5	46.5	33.2	18.7
Stock market index futures	110.0	127.7	172.4	195.9	211.5	321.0
Stock market index options	229.7	238.4	329.3	378.0	776.5	866.5
OTC instruments¹	8,474.6	11,303.2	17,712.6	25,453.1	29,035.0	50,997.0
Interest rate swaps	6,177.3	8,815.6	12,810.7	19,170.9	22,291.3	..
Currency swaps ²	899.6	914.8	1,197.4	1,559.6	1,823.6	..
Interest rate options ³	1,397.6	1,572.8	3,704.5	4,722.6	4,920.1	..

¹ Data collected by the International Swaps and Derivatives Association (ISDA).

² Adjusted for reporting of both currencies; including cross-currency interest rate swaps.

³ Caps, collars, floors, and swaptions.

Source: BIS, 69th Annual Report, May 1999.

The broader range of products for international investors translates into more opportunities for borrowers and lenders to match their desired pattern of risk and return. Not only has the range of products available at the international level broadened, but also the players in these markets have extended from banks to include insurance companies, pension funds and hedge funds –or institutional investors–, among other financial institutions.

However, as financial markets become more sophisticated, it may become more difficult for

investors and regulators to evaluate the risks incurred by the agents. This is particularly important because advances in technology allow instantaneous communications by which large amounts of money can be moved from one country to another in a very short time. Complex new products, such as derivatives, allow even investing in markets without the need to move the money there. With the globalization process, international markets have become more inter-linked and more clear barriers.

As financial markets become more sophisticated it may become increasingly difficult for investors to evaluate risk. This is particularly true of derivatives

The availability of computing power makes it possible to use sophisticated risk models virtually in real time. However, these models have proven to be far from infallible

One recurring characteristic in recent financial crises has been the increasing rapidity of contagion from the point of origin to other economies. IT is undoubtedly among the principal causes of this acceleration

Derivatives are among the new products that have made the greatest contribution to the transformation of the financial markets in recent years. Financial derivatives can be classified into two broad categories: forward contracts and options. In the former, one party agrees to buy something from another party at a specified future date for a specified price. In an option contract, on the other hand, one party agrees to provide the right, but not the obligation, to another, to buy or sell something in the future at a specified price. There are also numerous combinations of forward contracts (like swaps), option contracts (like straddles), or both.

The spread of financial derivatives has been made possible by advances in both technology and financial theory (risk pricing). In the area of risk management, technological developments have made it easier to keep track of the overall value of an investor's positions. Some years ago, calculating the overall risk faced by an institution even in just one location would take more than a few hours; nowadays, the technology allows a financial institution to compute almost instantaneously the value of its positions around the world. Similarly, technology and portfolio theory have had an impact on risk management by providing the means for an institution to diversify risk. The problems for market stability appear when these advances are implemented by institutions without accounting sufficiently for some of the flaws in the technique. Recent research, together with market evidence, suggests that these techniques tend to underestimate the level of risks faced by investors by not accounting sufficiently for recurrent episodes of financial turmoil, and the possibility that other market players are using the same technique

Recent financial crises

Following a period of increasing international integration of both goods and financial markets,

several crises have successively shaken the international financial system. The first signs of the crises were the speculative attacks launched in 1992-93 against several European currencies that were members of the Exchange Rate Mechanism (ERM). This resulted in the depreciation of the currencies of several European countries (including Sweden, which was not a member of the EU), and the modification of the bands that limited the movement of the exchange rates of the countries in the ERM.

In 1994 the Mexican currency crisis occurred, which resulted in a big drop in the Mexican peso, whose consequences were felt all over Latin America. In 1997, the depreciation of Thailand's currency triggered the Asian crisis, the worst financial crisis for many years. More recent events include the depreciation of the Russian rouble in August 1998.

A remarkable characteristic of all those crises is the *rapidity of the contagion* from the original point to other economies. There are several reasons for this; for instance, in many cases it affected trading partners, or countries with similar characteristics as the original one. And the *herd behaviour* typical of financial markets (which has its origins in information asymmetries) aggravated the contagion. But the most important factor explaining the rapidity with which the contagion took place is undoubtedly the influence of Information Technologies. Another key characteristic of recent crises is the geographic spread, the contagion-at-a-distance phenomenon whereby countries which have little contact with the point of origin of the crisis get "infected" (i.e. countries sharing few direct trading links or capital flows).

Box 2: Institutional response to financial crises

In response to the recent international financial crises, the main institutions that have responsibilities related to the international markets (International Monetary Fund, World Bank, Bank for International Settlements) have been involved in studying solutions. Meetings among governments (known as the G-N, where N corresponds to the number of governments) were also set up to coordinate the actions.

After the Mexican peso crisis in December 1994, the Halifax meeting of the G-7 countries held in 1995 initiated crisis-prevention work in a number of areas. This process resulted in the Rey Report of May 1996, which was written by a working group established by the G-10 countries (which actually has 11 members). As a result of the Asian crisis in 1997, finance ministers and central bank governors from 22 countries (the G-22 group), including key industrial and emerging market economies, held a meeting in Washington in April 1998 to investigate ways to reform the system so as to help reduce the frequency and severity of crises. More recently, this work has been put on a regular basis with a new G-20 mechanism.

Three key areas were identified: enhancing transparency and accountability, strengthening domestic financial systems, and managing international financial crises. (See also Greenspan, 1999).

As regards transparency and accountability, the main concerns are related to the compliance with, and enforcement of, high-quality accounting standards, and the diffusion of data on foreign exchange reserves, external debt and financial sector soundness. A more difficult problem is to have data on international exposures of investment banks, hedge funds and other institutional investors.

The strengthening of financial systems is concerned with the key areas of corporate governance, risk management and safety net arrangements.

The objective with respect to international financial crises is to set up mechanisms that help both to prevent them and to facilitate their resolution.

Sources: BIS, IMF, Federal Reserve Board (U.S.), and Economic Report of the President.

The role of national and international institutions and policy options in the new framework

All the actors involved (governments, institutions, and analysts) have advanced proposals to cope with the new environment and financial crises. Some of those proposals contradict each other; for instance, some would propose the establishment of tighter capital controls, while others would suggest eliminating restrictions on movements of capital. We have selected here a few of the most important proposals, and have grouped them under two headings: those for which there is broad consensus, and those that have raised more controversy.

Widely accepted proposals**Policies at the domestic level**

- Improved prudential supervision of financial institutions, taking into account the new possibilities that new information technologies have created. In particular, non-financial institutions that have started dealing in financial products should be subject to supervision.
- Supervisory authorities should not only pay attention to capital adequacy requirements, but also to the banks' risk management processes. The new technologies, together with the complex financial

products that have appeared, have made much harder the task of evaluating the actual risks faced by the banks, and have shifted attention to assessing the banks' systems of controlling risks.

- Consistent macroeconomic and fiscal policies intended to assure stability.

Policies at the international level

- Standardization of international requirements and supervision of domestic financial institutions. In particular, there should be harmonization regarding bankruptcy, restructuring and foreclosure laws, and deposit insurance mechanisms. These measures are needed mainly in the case of emerging economies.
- Increasing the transparency and accountability of financial market transactions at both the national and international levels.
- Coordination mechanisms and institutions that help both prevent and manage crises that affect several countries.
- Hedge funds and, more generally, highly leveraged institutions, should be better monitored and controlled. In particular, ways of extending control to offshore activities could be explored.

Controversial proposals

Some proposals that have been advanced are controversial. We summarize below some arguments in favour and against them.

Exchange rate regime

The major currencies traded on international foreign exchange markets belong to countries or blocs with flexible exchange rate regimes. In a

country with capital mobility, the possibility of an independent monetary policy is tied to the degree of flexibility of the exchange rate regime. From this point of view, flexible exchange rates would seem a good choice also for emerging economies. However, most emerging economies have a system with some exchange rate rigidity. The reason is that the rigidity of the exchange rate acts as a commitment towards macroeconomic policies intended to ensure stability, and in this way international investors are willing to invest in the country.

In the recent crises, the countries worse affected were those with a moderately rigid exchange rate, rather than those with a very rigid one. Because of this, some analysts advise choosing between one of the extremes: a very rigid or a very flexible regime.

Control of capital flows

In the recent crises, some emerging economies have experienced important capital flow reversals, that is, they have passed from a positive to a negative balance of flows. This has had disastrous effects on their economies. To prevent such problems, there have been proposals for controls on capital flows. The proposals were intended mainly to avoid drastic shifts in short-term capital flows. Most authors agreed that controls of *inflows* were preferable to controls on *outflows*. Controlling inflows is generally perceived as a preventive measure, while controlling outflows would be implemented as a means of dealing with a crisis. In the case of countries with rigid exchange rates, the control of capital outflows is supposed to break the link between domestic and foreign interest rates. Since most analysts consider the movement towards liberalization either as desirable, or as unavoidable, they emphasize the importance of stating at the outset the temporary character of the controls, and the criteria for their removal, so as to minimize any adverse effects on

economic agents' expectations. However, other authors are more sceptical about the effectiveness of capital controls, in the context of globalized markets, and given the possibilities for circumventing the controls that have been opened by new financial instruments and information technologies. For general discussions, the reader can refer to Edwards (1999), Fischer (1999), Rajan (1998), and Rogoff (1999).

Taxes on financial transactions

A tax on all foreign exchange financial transactions is called a *Tobin tax*. Its intention is the control of speculative, short-term international capital flows, without affecting the long-term flows. The objections against it are based on the difficulties of its effective implementation, unless it were coordinated among a number of countries (See Rajan (1998), and references therein).

Policy challenges for the European Union

As regards the banking industry, the EU Directive of 1989 established a well regulated framework within which to promote the creation of a single European market. However, there is no comparable regulatory framework applicable to securities markets. This is one of the main challenges the EU and its institutions face at the moment. In May 1999, the European Commission published an Action Plan containing priorities and timetables for measures aimed at improving the single market for financial services. The Action Plan includes measures to advance the harmonization of the legal framework and market information, and to facilitate investors' operations throughout the single market. Given the possibilities that new technologies offer international investors, unless the European securities markets are able to achieve better integration, they will lose competitiveness with respect to other international markets.

In fact, the possibility of trading via electronic networks will not automatically result in more efficient markets, but might also have the opposite effect if a good regulatory framework is not established. For instance, concerns have been expressed about the apparent lack of regulatory control over some on-line brokers. And this is potentially a particularly serious problem where the client and the broker are located in different jurisdictions, which is a much more frequent scenario now the Internet has made international trading more readily available to individual investors. At the same time, institutional exchanges and regulators are concerned about the possible *fragmentation* of the markets that may result from the appearance of electronic share-trading systems, and the repercussions this could have for liquidity. New electronic trading forums may tend to cherry pick, offering the most attractive, and hence also perhaps the most volatile, sectors of existing institutional forums. The main challenge for regulators in this area is to set up a more integrated framework that allows to enjoy the advantages of online trading and information processing, while preserving, and hopefully enhancing, the liquidity and transparency of institutional exchanges.

Conclusion

When analysing past experiences, people tend to focus on a particular aspect of the situation, say the exchange rate regime, and leave other features in the background, in order to advance a proposal that would remedy some particular situation. However, when we look at the general situation of the countries worse hit by the crises, we will always find structural deficiencies either in the financial system, or regarding some aspect of the macroeconomic policy. If all countries were to adopt the policies listed here under the heading

One proposed solution for the problem of capital flow reversals is placing controls on either capital inflows or outflows, or both. Nevertheless, there are doubts as to the extent to which this would be feasible in a global market

Securities trading over electronic networks will not automatically result in more efficient markets. Indeed, it may have the opposite effect if a good regulatory framework is not established

Widely accepted proposals, then it is likely that the importance of choosing among the **Controversial proposals** would be of less consequence.

Due to the internationalization of the financial markets, any measures that are taken to ensure their stability and efficiency should be

coordinated at an international level. The initiatives promoted by the IMF (International Monetary Fund), the BIS and the G-N governments (see Box 2), all go in this direction. Within this international framework, the European institutions also face particular challenges, like setting up better integrated financial services markets.

Keywords

information technologies, international financial markets, regulation, globalization

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The Impact of Corporate Spin-offs on Competitiveness and Employment in the EU

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Issue: Corporate spin-offs draw their competitive advantage from the experience acquired within the parent company in combination with the exploitation of entrepreneurial opportunities. They are not only a common, but also a highly successful way of starting up a new independent business.

Relevance: Corporate spin-offs face specific barriers and are shaped by their particular context. Thus, they often display very different regional frameworks, reflecting underlying industrial clusters and patterns of specialization. The coordination of various regional measures at European level promises considerable synergies, providing possibilities for aligning advances in science and technology (S&T) closer to enterprise innovation.

Corporate spin-offs: an underestimated phenomenon

In today's competitive environment, companies need to constantly monitor their strategic position and re-think their core competencies. As a response to this, companies have sought to restructure and reposition themselves so as to meet these competitive challenges more adequately. A part of this restructuring process is where companies decide to divest certain activities into corporate spin-offs¹, leading to the formation of new (or refocused) industrial enterprises.

In the US, the corporate spin-off process is more extensively monitored and better

understood than in Europe. However, the impact of spin-offs on employment and on the national and local economy in the US have not yet been assessed.

Until recently, scientists and business managers in Europe have taken corporate spin-offs into account in particular, if not exclusively, for their financial or organizational transformation and performance implications at corporate level. Policy-makers have focused attention on generic start-ups or university spin-offs, believing that they generate more innovation and jobs than corporate spin-offs. However, recent evidence shows that this attitude has to be rethought. In fact, although current information on corporate spin-offs is still partial, the available evidence suggests that they are important

In the current competitive environment there is a tendency towards increasing specialization. Companies often try to achieve this by spinning off activities which are not central to their business

Policy-makers have tended to concentrate on generic start-ups or university spin-offs. But, there is evidence that corporate spin-offs are more efficient at innovation and job creation

Spin-offs can be divided into two main types: those intended to reduce costs by externalizing activities that are not part of the company's core competencies, and those started by individual entrepreneurial initiatives

in the generation of new firms and jobs in the European Union (EU), in turn enhancing the long-term competitive position of the European economy. Thus, corporate spin-off activity generates important effects not only for the companies involved, but also for competitiveness and employment generation of the economy at regional, national and European level.

A number of actions implemented between March and December 1999 by the European Commission² have analysed corporate spin-off processes and assessed their potential impact on the European economy in more detail. They emphasize the relevance of corporate spin-offs for our socio-economic and industrial system.

In this framework, information about corporate spin-offs was gathered in the United Kingdom, Sweden, Spain, Italy, Germany, France, and Denmark. To complement this information, a questionnaire-survey was addressed to large and medium-sized companies across the EU. Furthermore, a working seminar was held with high-level representatives from industry, academia and the European Commission in order to assess the findings and propose further actions.

This article, which also refers to the results obtained from a first analysis at pan-European level, seeks to provide an initial overview of the phenomenon of corporate spin-offs at European level and its potential implications for EU policy.

Characteristics of corporate spin-offs

Corporate spin-offs can be grouped into two types. Spin-offs resulting from **restructuring** activities of large companies, and which are undertaken in order to dispose of businesses that no longer fit the parent company's core strategy, externalize functions in order to reduce costs, or avoid direct layoffs and costly social plans. This

type of spin-off is particularly evident in countries such as France, Germany and Sweden.

On the other hand, there are corporate spin-offs resulting from individual entrepreneurial initiatives. These **entrepreneurial** ("pro-active") spin-offs are formed when the spin-off entrepreneur forms a new company based on critical know-how acquired during his/her previous professional experience in order to exploit unused potential. Entrepreneurial Corporate spin-offs appear to be more common in Spain and Denmark, where there are fewer large companies undergoing major restructuring, and which have a relatively more significant SME base. Within entrepreneurial spin-offs, two types can be distinguished: Those where the spin-off firm seeks to continue to collaborate with its former parent, and those that compete with their former parent company. It may be assumed that these two types of entrepreneurial spin-offs exhibit different success rates, but there are as yet no comparative studies on this.

Each of the countries mentioned displays a different corporate spin-off environment and profile.

The key factors encouraging restructuring-driven corporate spin-offs centre on the need to downsize and increase turnover per employee. Activities that are not within the company's core-competencies and that do not meet minimum performance requirements are either closed down or spun-off. However, parent companies are often interested in collaborating with their spin-offs in order to fill production or capacity bottlenecks. The costs involved are crucial in terms of the decision whether to spin-off or close down an activity. Moreover, sectors with high spin-off frequencies are sectors that undergo a high level of cost-cutting. Deregulation seems to have been one of the driving factors in encouraging the emergence of corporate spin-offs in the energy and telecommunications sector. Many corporate spin-offs are highly leveraged, because

Box 1: The relevance of corporate spin-offs in Europe

- **Role for New Firm Formation:** Corporate spin-offs play an important role for new firm formation. Expert estimates in 8 European countries³ suggest that they account for an average 12.9% of new firms created. However, spin-off rates vary considerably between geographic regions and sectors of activity.
- **Job Growth:** Some country studies stress the healthy growth prospects of corporate spin-offs (at least 8% in employment terms, higher in terms of asset growth) combined with a very low failure rate of around 15%. UK and Swedish research confirms this. Corporate spin-offs display above average growth and low failure rates, producing positive direct employment creation effects. Job displacement effects appear to be negligible.
- **Innovation:** One study found that corporate spin-offs produce a higher number of innovations than New Technology-Based Firms (NTBFs). Furthermore, corporate spin-offs are an important element in the creation of NTBFs. Corporate spin-offs therefore represent a key driver in creating a technologically competitive environment.
- **Entrepreneurship:** The study revealed that corporate spin-offs are important in unleashing entrepreneurial potential, both by creating new, dynamic enterprises and also by creating leaner, more competitive and more focused parent companies.
- **Long Term Growth Potential:** Given that corporate spin-offs appear to combine high turnover growth with a significantly lower failure rate, they seem to be a driving force and consolidating factor for industrial growth. However, some restructuring-driven spin-offs show weak performance during the first few years after the separation, mainly due to costs associated with the transformation of the spin-off to a 'stand-alone' company.
- **Benefit for the Former Parent Company:** The loss of the activities of the corporate spin-off helps restructure the parent's value chain and reduce its costs or raise its efficiency, whilst the parent company reduces risks from a non-strategic business and gets rid of potential (future) losses. US evidence suggests that restructuring leads to higher parent firm growth and performance.
- **Aiding Regional Competitiveness:** After the separation process, corporate spin-offs concentrate more on local and regional supplier and customer relations thus fostering regional competitiveness.
- **New Market Creation:** Corporate spin-offs have been shown to create new markets, in turn helping to raise European competitiveness.

Source: Moncada et al. (1999)

they have to finance the separation from the parent company, the transition to a stand-alone company and the investment in new products and markets. During the transition period of between 3 to 5 years, the asset growth of the spin-off is therefore high, while economic performance is relatively weak.

Corporate spin-offs: a success in Europe

Recent analyses reveal that corporate spin-offs are an important activity in **maintaining**

and enhancing the competitiveness of European industry, that they represent an important source of **employment growth**, and that they are **important for regional economies** in terms of creating indigenous growth opportunities.

More particularly, Europe appears to be successful at spinning-off companies and sustaining and growing them after the process (See Box 1).

Comparison of the framework in different European countries reveals that greater flexibility and incentives for new firm creation can have a strong positive influence on spin-offs

It also has to be highlighted that corporate spin-offs, as a feature of industrial success and dynamism, follow a pattern that is quite unique. Their activities are much more regionally concentrated than their parents', so that spin-offs are more dependent on regional industrial structures and are more likely to appear in vibrant industrial clusters.

Barriers and supportive factors

Spin-off processes are not automatically successful. Examples of failed spin-offs can be found, in particular enterprises that are spun-off in order to dispose of unprofitable businesses or to create short-term profit maximization for the parent. However, the positive effects of corporate spin-offs on competitiveness seem to clearly outweigh the negative ones.

There are a number of factors which encourage or hinder corporate spin-off processes and their success. Firstly, the support from the **parent company** is decisive for the success of the spin-off. corporate spin-off schemes offered by the parent company can be a key-driver for the creation of entrepreneurial spin-offs. The **management and implementation** of the spin-off process is in fact a main obstacle for the success of the process. Therefore, any effort made by the parent company during this phase can be extremely beneficial.

The **financial incentives** for the management of the spin-off are also of crucial importance for the success of the process. In the case of Management Buy-Outs (MBOs), these incentives are provided by the management's equity share in the spin-off. Unfavourable taxation of equity holdings or stock-options constitutes a major disincentive, undermining the risk-reward relation of entrepreneurial spin-offs in particular.

Furthermore, the comparison of the **political, legal and fiscal framework** of the United Kingdom with the other countries reveals that more flexibility combined with incentives for new firm creation positively influence the creation of corporate spin-offs. The absence of favourable political, legal and fiscal frameworks constitutes a major obstacle for corporate spin-offs.

Finally, it should also be pointed out that, in some EU countries, the negative influence of **cultural** views of entrepreneurial failure as a personal failure appears to be an obstacle of considerable magnitude.

A role for policy?

Corporate spin-offs have the potential to produce **superior** direct and indirect impacts on employment and competitiveness compared to other measures that support the formation of new firms. This is due to the fact that corporate spin-offs tap into and profit from their former experience and relations acquired within the parent company to build the new business. Therefore, they begin with a competitive advantage compared with other types of new companies. This produces lower failure rates, higher growth, and longer-term stability at corporate level. Policy options regarding corporate spin-offs can thus offer the potential to be more effective than measures aimed at supporting 'normal' firm start-ups. However, it should be taken into account that measures concerning corporate spin-offs should be well-balanced in order not to handicap normal firm formation. A number of policy options are presented in Box 2.

Corporate spin-offs have demonstrated themselves to be an important source of industrial reinvigoration and improving competitive advantage. Spin-offs create important growth and

Box 2: Policy options to support corporate spin-offs

- **Measures that foster the incentive to spin-off** could be created, for example, through revised taxation schemes for equity holdings in spin-offs.
- **Measures that help parent and spin-off companies cope with labour and organizational costs generated by the spin-off process.** This could include the support given by the parent company to the spin-off or be directed to cover the organizational costs of change for both companies
- **Measures that allow more flexibility in labour relationship** and promote adequate labour arrangements, such as secondments, leaves of absence or transfers.
- **Measures that increase the visibility of successful corporate spin-offs and their wider benefits,** for example via benchmarking of experiences and good practices.
- **Measures that favour the adoption of co-operative practices between parent and spin-offs,** for example by supporting the start-up of "horizontal clusters" or "company clubs" for corporate spin-offs. These instruments would be managed by companies and for companies and thus provide a platform for the exchange of experience and information.

Source: Moncada et al. (1999)

innovation opportunities. In fact, corporate spin-offs have to be adequately considered in innovation and employment policy if Europe is to aim at substantial employment renewal and growth over the next twenty years.

Policy-making should give particular consideration, preferably at a pan-European level, to the three major aspects of corporate spin-offs.

First, support for corporate spin-offs would contribute to the **strengthening the single market** and its **competitiveness**. Especially when compared with the US, corporate spin-offs are an instrument that has not been sufficiently considered in European industrial policy to date.

Secondly, corporate spin-offs follow different regional patterns, which depend largely on the industrial clusters present. The **calibration** of various regional measures on an international level promises **considerable synergies**, which provides **unique possibilities** for strengthening European competitiveness and employment while respecting European diversity.

Thirdly, due to the diversity of entrepreneurial activities and the complexity of industrial change, **political actions in favour of corporate spin-offs should represent an important -but not the only-** action within this general area of stimulating entrepreneurial activity and competitiveness within the European Union.

In the design of measures that support corporate spin-offs, three major threats have to be taken into account by policy-makers. Public support measures directed at the spin-off company could replace support that otherwise would have been provided by the parent company, the danger here being that this could end up benefiting the parent rather than the spin-off. Then there is the danger of parent companies creating 'apparent' spin-offs that could benefit from public support but which are still informally controlled by the parent. A consequence of this could be the creation of a dominant position for the parent company, which still has *de facto* control over its network of offspring. Also, public support towards spin-offs could put other types of new firm formation at a disadvantage. In addition, both companies

Any direct public support for spin-offs needs to find a way of avoiding the risk of parent companies setting up artificial spin-offs to take advantage of these benefits. It would also have to ensure it treats other start-ups fairly

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and policy-makers should also consider the possible negative impact, which could emerge when a non-agreed transfer of intellectual property and capital from parent companies to entrepreneurial spin-offs takes place.

Conclusions

Taken in isolation, the issue of corporate spin-offs is both old and new. There is no doubt that many new companies are set-up to take advantage of previous business experiences. The "new" side of the issue is that corporate spin-offs have not been appropriately addressed in the European Union despite their rising importance within corporate strategy and their considerable benefits for competitiveness and employment.

Corporate spin-offs are subject to a **complex interplay** of entrepreneurial, technological, and environmental factors. The **definition** and **typology** of corporate spin-offs needs to be developed and standardized across Europe⁴. On

this basis, **best practices** of corporate spin-off procedures and the **extent** of these effects at **national** or **European level** could be identified. **Spin-offs from small and medium-sized enterprises (SMEs)** are subject to different restrictions and motivations⁵. A more precise knowledge about the mechanisms that create spin-offs from SMEs would open up considerable potential for value creation at European level. Further, there is evidence that **research-based spin-offs** from public institutions could especially benefit from evidence about corporate spin-offs⁶. After having reached a certain level of development, research-based spin-offs need, and can benefit from, the same instruments as corporate spin-offs.

In conclusion, corporate spin-offs in Europe are important processes in successful industrial transformation and innovation. As a factor in linking S&T advances closer to enterprise innovation, corporate spin-offs offer the potential to be a key driver of Europe's technological renewal.

Keywords

spin-offs, competitiveness, employment, innovation, industrial policy

Notes

1. The following definition has been used: "A corporate spin-off is the division of an existing company into two, usually a bigger one (the parent company) and a smaller one (the spin-off). Corporate spin-offs are often the result of restructuring or reorganisation of the parent company. However, they might also be formed when employees are not able to realise their ideas in the parent company and buy-out the necessary organisation or infrastructure. The definition refers to corporate spin-offs from large and medium-sized companies (i.e. with a parent company before spin-off minimum annual turnover of at least 7 million Euro or a staff of at least 50 employees at the time of the spin-off). It also comprises all industry and service sectors and the whole geographic area of the country concerned."
2. JRC-IPTS and DG-ENTERPRISE, with the support of the ESTO network. ESTO is the JRC-IPTS' European Science and Technology Observatory, which currently comprises more than 30 major European policy advice organizations and has links to overseas organisations.
3. Denmark, Finland, France, Germany, Italy, Spain, Sweden, and the UK (see Moncada et al. (1999), pp.109).

4. The new Swedish approach, using individual career-pattern information, provides an interesting example that could be adapted and applied to other EU countries.
5. For example, SME spin-offs noted the access to finance as a considerable obstacle, while restructuring-driven spin-offs from large companies did not consider the access to finance as a major problem.
6. See OECD (1999).

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SMEs play a very important role in Europe's economy, particularly in terms of competitiveness, innovation and job creation

Access to Publicly-Funded RTD programmes: EU Government Measures

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Issue: Difficulties of access to publicly funded RTD Programmes are a common problem shared by SMEs in most European Countries. Common solutions are perhaps not yet available, but analysing the typology of research objectives can help and support policy formulation.

Relevance: Studying difficulties of access to publicly funded RTD Programmes is a way of defining a new access procedure and assessing research objectives.

Introduction

This article sets out to analyse the main factors relevant to the dissemination of information about the conditions of access to publicly funded RTD Programmes and the particular problems affecting SMEs wishing to participate. In particular, potential applicants need to know about the research objectives, application procedures, the type and permitted uses of funding, etc. Clearly, broad participation would also be encouraged by greater awareness of the benefits for SMEs of participating in such programmes; and this information could be put on a more objective footing by improving the means of evaluating the impact of research results.

The benefits for SMEs

The importance of SMEs in the context of the "triple challenge of more growth, greater competitiveness and more jobs" in EU Countries

has risen rapidly over the last ten years: the 15.8 million SMEs employing less than 250 people represent 99.8% of all EU's enterprises and account for 66% of total employment and 65% of the Union's business turnover.

During the last five years, SMEs have created more than 80% of new jobs. Some of them work as subcontractors helping larger firms to be more competitive, others are increasingly making important contributions to innovation in rapidly evolving sectors such as multimedia, software development, and environmental technologies. Publicly Funded RTD Programmes in the EU, permitting research costs to be shared between participants, create opportunities for SMEs to improve their technological base and internationalize their business network.

By taking part in RTD Framework Programmes SMEs can participate in a number of types of research-related activities:

Box 1: Diffusion of information

The optimal diffusion of up-to-date and appropriate information may depend on a number of factors:

- **Widespread diffusion and use of ICT:** putting information online can make it easier to connect people while at the same time decreasing the costs of information dissemination and providing more flexible support.
- **Efficient service-provider networks:** the right contacts for additional information, clarity of official documents, checking the quality and eligibility of proposals, are all factors which influence the success rate of submitted proposals.
- **Financial contributions promoting access:** EU measures without national contributions are not able to promote a significant improvement in SMEs' access performance, the participation costs remain high, particularly in terms of the availability of management time, the risk of not being selected and the limited resources available to perform R&D activities.
- **High educational level:** staff working in various organizations, ministries, research centres, companies and on the management of SMEs, need to improve their efficiency through adequate professional training and retraining in order to be able to access and to analyse contents of publicly funded RTD Programmes, to connect them to companies' funding needs and to forecast production strategies.

- Exploratory Awards: in which they receive funding of up to 75% from the EU for preparing research proposals;
- involvement in Collaborative Research Projects with large companies, universities, and research institutions in the EU, for which they can benefit from Commission funding of 50% of the costs;
- Cooperative Research (CRAFT) Projects, grouping together SMEs with similar technical problems and similar shortages of resources for research, thus enabling them to engage in RTD Programme proposals.

The satisfaction rate among SMEs participating in the 4th Framework Programme was very high: an indicative negative statistic is that only 4% of participants said that they would not participate again. However, the percentage of ineligible proposals, both for Exploratory Awards and CRAFT, was around 60%. This was due to proposals being "not in line with programme priorities". Measures taken by the EC -Technology Stimulation Measures for SMEs (TSME) included- do not yet seem able to

get the right information across to SMEs. Thus the absence of direct lines of communication between SMEs and the EC's information and assistance services continues to be a barrier.

- The Final Report on the Fourth Framework Programme suggested several corrective measures, many of which have been incorporated in the Fifth Framework Programme.

Evaluating the impact of research results**Impact on company's organization: costs and benefits**

Classifying the negative impact as costs and the positive impact as benefits, a number of consequences of participation in RTD Programmes emerge for company organization.

Costs:

- *Delays between the time of submission of a proposal and its approval:* This implies an investment of both time and money. The

The overwhelming majority of SMEs involved in the Fourth Framework Programme were satisfied with the outcome

The main drawbacks of participation for SMEs are the investment in time (particularly management time) and money, the time taken to process applications, and the high rejection rate

The benefits for SMEs include improving their technology base, building international relationships and enhancing the company's image

overall delay is about 12 months: 5 or 6 months for the preparation of a proposal, plus about 5 months for EC evaluation, plus about 4 1/2 months for contract negotiations. Thus the outlay for the preparatory steps (about 24-28kEURO per proposal) can be considerable. This is not covered by EU funding even in the case of the Exploratory Awards. Clearly, if the proposal is rejected, all the time and money spent on it are lost. Moreover, to submit the rejected proposals to a different EU programme entails an additional investment as the requirements for each are different.

- *Large number of rejected proposals and low approval rate:* Companies presenting proposals prepare several proposals for different themes, so as to have a higher chance of being selected for at least one.
- *Management time:* The management time required is a burden, particularly for SMEs.
- *Investment in time and money:* Preparing several proposals means not only more time and more money, but potentially also losing the opportunity of opening other lines of activity: in particular when the proposals are rejected.

Benefits:

- *Ownership of new products or rights to process innovations:* research costs are shared with the EC and partners so allow a reasonable return on the outlay.
- *Improving the technological base:* acquired knowledge is employed to improve all areas of production, with the added benefit that research costs are shared with the EC and partners.
- *ISO and EU (CEN/CENELEC) Standardization of processes and products:* this often emerges in this context for both innovative industrial processes and products and is essential if Companies are to remain competitive in the enlarged European market.
- *Better understanding of market strategies:* participation in Exploratory Awards rather than in Collaborative or Cooperative Research Projects can improve knowledge of supplier's and competitor's strategies as well of the end-user's needs. This attracts venture capital with which to implement solutions of common technical problems and to allow better exploitation of the products.
- *Market enlargement through internationalization of the business network:* A large proportion of companies' production can often benefit from contacts abroad, and intensive exchanges of goods and services are often one outcome of participation in RTD Programmes.
- *Enhancement of company image:* Projects selected by the EC often find it easier to obtain finance. Also, the fact that the firm is mentioned in the Companies profile gives it publicity, and opens up possible connections with other companies, nationally and internationally.

It is very hard to compare costs and benefits, and to evaluate the importance for companies, and SMEs in particular, of participating in an EU RTD Programme: a study addressing this issue needs to be carried out to clarify the real efficacy and the efficiency of RTD Programmes. More specifically: "... (for the) parameter in the R&D investment function (that) reflects the adjustment cost related to the introduction of an innovation in an organization... (the) higher the adjustment cost is, the lower the investment in R&D: that explains

the company's internal opposition to investing in research" (Varsakelis, 1999). In addition, the impact evaluation of RTD Programmes must pay attention to the Countries' economic context.

Empirical data from various sources, furthermore, give reason to suppose that benefits largely outweigh costs and so create an incentive for participation: According to the 1998 Final Report, the SME Coordination Unit¹ reported that 64% of SMEs participating in the 4th Framework Programme were newcomers, and 96% of the all participants in Collaborative and Cooperative RTD stated they would be keen to repeat their involvement. This means, on the one hand, that there is considerable interest in information from partners or from successful experiences of companies in other European countries, and also that research objectives were met.

Protecting innovative results

In the EU's Fourth Framework Programme only 1/3 of consortia including SMEs legally protected their research results, and only a slight majority of SMEs signed a Consortium Agreement, in all cases only after signing the contract with the EC. It seems SMEs underestimate the importance of addressing the legal and intellectual property issue, but for proposals submitted under the TSME, the legal assistance service was something for which they were more than willing to pay. As a matter of fact the protection of research results is a very important element, but is not yet sufficiently linked to the activities of RTD Programmes. Certain changes may be appropriate to improve National and European Patent Procedures. The shortcomings of the current system include:

- European Patent costs (both national and European) are three or four times higher than those of US or Japanese equivalents;

- A European Patent is not yet a Community Patent, there being no single patent automatically applicable throughout the Community;
- Lack harmonization of protection at Community level. (As a step in this direction the recent proposed Directive aimed to harmonizing Member State's laws on utility models should be mentioned. This covers their automatic use, for example, in connection with RTD Programmes, and could offer efficient protection of technical inventions, especially those with a short lifetime or involving only a small inventive step);
- The long time from application to granting of a patent;
- The high rate of counterfeiting and piracy in the Single Market.

All these points of weakness in the patent system contribute to keeping companies' estimates of legal protection in RTD Programmes low and thus keeping their interest in innovation low too. Building up a connection between the two (RTD Programmes and Patent Systems) could contribute to improving the economic impact of RTD Programmes.

Conclusions

It might be beneficial to improve the use of EU RTD Funds and to open up access to a larger number of SMEs. To achieve this, a mix of national and EU strategic measures could be proposed:

Measures by National Governments

National Governments could promote access through a variety of measures:

It is difficult to get an objective measure of the costs/benefits of participation for SMEs, and further investigation in this area would be a valuable part of optimizing the allocation of research resources

The European patent system is not well suited to SMEs, which find it slow and costly. The lack of unified pan-European protection is also a problem

- Enhancement of the education level of the working population, placing emphasis on building ICT skills: for example, including a free PC for home use and training for the employee's family in the renewal of national work contracts;
- Tax breaks for Companies adopting up-to-date ICT (this may be more important for SMEs);
- Grants and/or loans, at low interest rates, for SMEs participating in Publicly Funded RTD Programmes for Exploratory Awards;
- Employment policies encouraging involvement of young researchers by means of tax breaks, in particular for SMEs;
- Innovation strategies to increase household use of ICT:
 - contributions and discount for families buying their first PC;
 - lower telephone and Internet access charges.
- Patent strategies:
 - shorter delays between submission of applications and granting of patents;
 - lower patent fees for SMEs;
 - low cost loans for SMEs designation fee and to market launch of the product.
- harmonization and direct connection of National Patent Systems with the Community Patent System.

Access promotion measures

A number of measures could be envisaged as ways of promoting access:

- Automatic patent for EU Publicly funded RTD Programmes which produce innovative products and industrial processes, with a waiver of the patent fee;
- EU Publicly funded RTD Programmes for promoting SMEs (without own research resources) involvement of young researchers through grants for Exploratory Awards;
- Modification of the heavy procedures concerning management of the Projects.
- Consolidating of a Single Entry Point for Proposals with systems able to evaluate their eligibility, to classify them by Programme Priorities or/and to send them to the appropriate Programmes;
- Quickly define new features for a Community Patent and measures to facilitate its adoption.

Keywords

research impact; S. & M. firms; publicly-funded RTD Programmes, objective evaluation

Note

1. Final Report – 23 June 1998. European Commission DGXII, SME Coordination Unit.

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Dr. **Giovanna Anselmi** graduated in Political and Social Sciences at the Catholic University of Milan in 1970. Until 1983 she carried out research into Economic Planning and Social Politics at ISPE (Italian Economic Planning Studies Agency). In 1983 she joined ENEA, the Italian Agency for Energy, Environment and New Technologies, where she is on the Staff of the Central Studies Directorate. Her Professional Interests concern the Impacts and Changes in Economic, Social and Cultural Scenarios of IC Technologies; Technology Assessment and Sustainable Growth Studies.

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