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THE EFFECTS ON GROWTH AND EMPLOYMENT.

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Abstract

Unemployment has remained at relatively high levels across most European countries for a generation now. There have been a number of suggested explanations for this, with correspondingly different policy implications. Two of the major hypotheses relate first, to the impact on the European economies from increased international competition and ‘globalisation’ more generally, and secondly, to the effects of new technology and innovation. There are of course many different factors involved within each of these explanations. And as with most economic processes, there are all sorts of linkages between the factors at work under each of what are in reality rather broad headings.

The role of multinational corporations is just one of the more obvious factors that both affects and is effected by processes of globalisation and of technological innovation. Indeed, there has emerged a whole literature around the phenomenon of ‘technological globalisation’—the extent to which the new technologies have driven globalisation rather than the other way around, the degree to which multinational corporations have become truly global companies rather than remaining nationally based companies simply operating globally, and so on.

This is the background to the EU-wide research project conducted from 2000-2002 ‘Assessing the Impact of Technology and Globalisation: The effects on growth and employment’ (AITEG), the results of which form the basis of this report. The research from the AITEG project, have illustrated the sort of policy agenda that can encourage firms to innovate and to create productive links with other firms and institutions. Some of these policies will still—despite globalisation—be country specific. But it is important that, at least on the European level, government policy is not diverted down a simplistic goal of just attracting as much inward investment as possible, away from other ‘competitor’ economies or confined to the ‘supply push’ approach of funding R&D projects leading to labour-displacing process innovations.

To get the most from footloose capital and transnational economic organisation, national governments need to focus on how to upgrade their own domestic economies. Firstly, this will maximise the chance of domestic firms being able to forge international links and benefit from them. Secondly, the domestic economy will thereby prove attractive to the sort of inward investment that is likely to contribute to rather than just take advantage of the domestic economy. And thirdly, it will maximise the beneficial impact that such investment is likely to have in terms of linking with domestic firms and contributing positively to the existing national systems of innovation. Innovation policy needs to be targeted towards industries with the greater potential for growth and employment, and specific actions should be directed at the needs of individual industries. And finally there needs to be a strong coherence between industrial, technology, learning and macroeconomic policies.

1. Executive Summary

Unemployment has remained at relatively high levels across Europe for several decades now, ever since the mid-1970s. An entire generation has lived with unemployment in Europe—relative both to Europe’s previous record of generally full employment, and also relative to the rest of the industrialised world. There have been a number of suggested explanations for this, with correspondingly different policy implications. Two of the main hypotheses in the academic literature have focussed on the roles firstly of globalisation and increased economic competition from outside Europe, and secondly of technological innovation and ‘jobless growth’.

The effects of both globalisation and technology on growth and employment in Europe have been researched over the past two years through the EU-funded project, “Assessing the Impact of Technology and Globalisation: The effects on growth and employment (AITEG).” The AITEG project has led to a variety of results that have interesting policy implications, which are summarised, in this section of the report. There are many linkages between globalisation and technology, the role of multinational corporations is just one of the more obvious factors that both affects and is effected by processes of globalisation and of technological innovation. Many of these linkages are explored in the individual papers, but for the most part papers from the project have been grouped around the two different themes of ‘globalisation’ and ‘innovation’. As such the main findings and policy implications presented here will also follow along these lines.

1.1 Innovation

The research for the AITEG project on innovation has spanned across three main areas:

1. Theoretical and empirical analysis of the effects of technological change.
2. Patterns and impact of technological change in European industry: Evidence from European Innovation Surveys
3. National studies on innovation in industry and services

The studies in this area address all levels of analysis in order to establish a link between innovation, economic performance and employment that is grounded in theory and investigated through empirical analysis. The research ranges from country level studies addressing the macroeconomic performances of advanced countries to firm level analysis focusing on skill bias and technological change. With such a range of studies it is no surprise that the reported effects of technological innovation have been mixed—with some studies showing technological innovation having a negative impact on overall employment. However, the majority of the studies do find that using a targeted innovation and industrial policy there is scope for increasing employment. But this requires a strong coherence between industrial, technology, learning and macroeconomic policies.

1.1.1 Theoretical and empirical analysis of the effects of technological change

The detailed work carried out by the project on innovation indicators, linked to the dynamics of international production, has been based on the newly available Community Innovation Surveys and has opened up a new set of crucial research questions.

A first new theoretical challenge questions the idea of the homogeneous nature of innovation carried out in firms. Not only the theories of neo-Schumpeterian and evolutionary approaches, but also the rich evidence of innovation surveys now suggest that different models of innovative activities are present, and characterise particular sectors or national economies. A major cleavage has been found between innovation strategies aiming at either product or process innovation. But more refined typologies are also clearly emerging.

A second challenge questions the idea that innovation has an automatically positive impact on economic performance. Again, careful theorising, and now also empirical studies, have suggested that different innovation strategies, which characterize particular sectors, may have diverse effects on economic growth and employment patterns, and on the associated developments in international investment and production.

A third challenge is to integrate the new view of innovation in macroeconomic relations within the complex interaction of demand and supply, the web of substitution and compensation effects, and the turning points in structural change and distribution patterns.

Models of technological change

The need to understand the variety of innovations, the diversity of their possible effects and their complex links to macroeconomic issues is made more urgent by the current emergence in advanced economies of the new techno-economic paradigm based on Information and Communication Technologies (ICTs). The questions for theory and empirical research lead in this context to a set of policy options of great importance to European economies.

The radical change in the nature and trajectories of innovations produced by the new techno-economic paradigm is at the core of the latest, short-lived fashion in economic studies and policy, namely the infatuation with the 'new economy' (OECD, 2001). Economic developments during 2001 in the US and the world economy proved that the widespread expectations of continuing rises in stock prices, in the rates of growth of GDP and productivity, and of an 'end of business cycles' to be massively exaggerated. The flop of the 'new economy', however, does not mean that change stops. Rather, it is likely to follow the more complex, long term route of diffusion of a new techno-economic paradigm shown by the history of the emergence of new pervasive 'technological systems' with large potential for change. Sustained and sustainable growth can be expected only once the mismatches between the new technologies and the old economic and social structures and institutions are overcome,

in a two-way adjustment of the latter to the requirements of new technologies, and of re-orienting innovation and adapting it to social needs and economic demands.

From our perspective, the most important implication is the possibility of different models of innovation, depending on the constraints posed by existing economic structures, on the competencies available, on the specific strategies pursued by firms and governments. In a very simplified way, four possible innovation models can emerge, relevant for both analysis and policy.

1. *ICT focused.* In this model, innovative efforts are concentrated on the activities based on ICTs and on their applications. The technological opportunities of ICTs are the driving force of growth, although operating from a rather narrow base of technological and economic activities. The ability to extend their impact and applications across a wide range of economic activities is a key test for success.
2. *Learning based.* Here the key process shaping technological and economic change is the learning activity by people and organizations. In the place of technology-driven growth, change is shaped by the evolution of competences, by the upgrading of economic activities, production organization and human skills, and by more complex social processes related to specific economic and social priorities. This is likely to lead to different qualities of economic growth and an improved quality of employment.
3. *Product innovation based.* In the firms and industries with well established markets the opportunities of technological change can lead to a strategy based on the introduction of product innovations and the expansion of new markets, often integrating applications of ICTs. This can represent a dynamic reaction to competitive pressure, leading to growth in both production and employment.
4. *Process innovation based.* This model applies to the more traditional sectors of the economy, where the pressure from competition leads to a search for cost cutting and process innovation. Such a course is likely to lead to restructuring of firms, concentration of industries, modest growth and large job losses.

Each of these models is associated with different types of innovation and with different consequences for economic and employment outcomes. Moreover, they interact with a set of other processes affecting the sources of innovation in knowledge and learning; the global reach of technological change; the link with the economic structure and with the demand side.

The variety of these factors, the differences in innovation models and the distinct strategies which can be pursued by firms and governments suggest that no automatic link can be expected between innovation and growth performances in the context of the current changes in technologies and economic structure. Far from being a deterministic process, the economic and employment outcomes of specific models of technological change are the result of social processes, where institutions, government

policies and social relations play a major role, alongside the developments in technology and the strategies of firms. The challenge for economic research on innovation is to develop a more solid understanding of these issues, relationships and contexts, advancing at the same time theory and empirical research.

1.1.2 Patterns and impact of technological change in European industry: Evidence from European innovation surveys

One of the major problems with innovation studies has been the difficulty in assessing and then measuring what constitutes innovation. As expressed in Michie, Oughton and Pianta, 2002 many studies use proxies such as R&D expenditures (as inputs into innovation) and patenting (outputs of innovation) to get some idea of the innovativeness of the firm. However, these are only partial measures, and account for only a portion of the inputs and outputs of the innovation process.

Many of these conceptual and data constraints which have long forced innovation into a 'black box', off-limits for economic research, are now disappearing. New theories are filling the gaps between the understanding of technological change and the functioning of economies; data shortages are replaced by opportunities. For the first time, a large data set on innovation is becoming available for a large number of countries with extensive information on the characteristics, objectives, nature, quality, expenditure and economic impact of the innovative activities carried out by firms. This is the result of the decision by Eurostat and the European Commission to adopt innovation surveys as a systematic source of information on technological activities in firms. The data collected by the Community Innovation Survey referring to the years 1994-96 (CIS 2) can now be linked to the previously used technology variables and to standard economic indicators.

The AITEG research carried out by Nascia and Perani and Antonucci and Pianta take advantage of the rich information contained in the CIS 2 data to provide useful overviews and analysis of innovation patterns, as well as the distinction between product and process innovations in manufacturing industries.

Nascia and Perani provide a useful overview of the results of the CIS 2, providing basic information on the characteristics of innovation in manufacturing industries in all European countries. These are clustered in three major classes: the industries dominated by product innovators focusing on markets, the group of process innovators focusing on costs, and sectors emerging as 'general innovators' which combine both strategies in order to advance on all aspects. Within European industries, some innovation dimensions appear to be the result of specificities of national innovation systems, while others are common features of sectors across all countries, as shown by an analysis of variance. Finally, regarding the economic impact of innovation - as described by the share of sales of the industry due to product innovations - the total expenditure for innovation, the R&D component, and the co-operation with universities are all found to be important factors.

The paper by Antonucci and Pianta addresses the controversial issue of the impact of new technologies on jobs. The authors use CIS 2 data at the sectoral level, associated with economic and employment variables, covering manufacturing industries in eight

European countries. Antonucci and Pianta develop a model where employment is affected by demand dynamics, labour costs and innovation variables associated with strategies of technological or price competitiveness. The empirical findings show that European industries, in the context of the modest aggregate growth of the 1990s, were dominated by the latter strategy, associated with process innovations, leading often to generally negative effects on jobs.

1.1.3 National studies on innovation in industry and services

Within the project more in-depth studies of innovation were carried out in manufacturing and service industries using a cross section of countries including the UK, Italy, and Spain. These studies investigate the 'black box' of innovation to point out the key elements shaping the direction of technological change and the factors more frequently associated with successful economic and employment performances for firms and industries. Additionally, the continuous proliferation of new services on a global scale and the increasing share of the service industries in national employment suggest that services are the core of the current process of structural change in modern economies. The research by Sellenthin and Hommen; Cox, Prevezer and Frenz; and Evangelista and Savona exams these issues more closely.

Sellenthin and Hommen's study involves a statistical analysis of the Swedish CIS-II database, focusing on innovation in the manufacturing sector. Based on data from the CIS, the study identifies the various innovation strategies used by industries in the manufacturing sector and using factor and cluster analysis relates these to different typologies and theories of innovation strategy.

Cox, Prevezer and Frenz develop a paper on patterns of UK innovation activities. They examine how the OECD classification of industries into high, medium-high, medium-low and low technology industries calculated for the whole of the OECD countries shape up in comparison to the UK CIS2 results. The second part of this paper contrasts patterns of innovation activities in the high technology industries with those in low technology industries for the UK. The main conclusions from this examination of innovation patterns are the following. The relation between product innovation and high technology industries is confirmed - that there is a strong relationship and high technology industries do tend to do more product innovation than lower technology industries. This does relate to higher research intensity, so it appears that higher R&D expenditures do lead to greater product innovation. Process innovation is not such an obvious case, with no clear division between high and low technology industries in their capacity and tendency to do process innovation.

A study of services industries using CIS 2 data in Italy is undertaken in the paper by Evangelista and Savona who present an overview of the problems and findings on innovation in services and test the impact that this has had on jobs in the 1990s. Again, an overall negative effect is found, concentrated among the largest firms, on low skilled workers, on capital intensive and finance-related sectors, and where the impact of ICTs has been most widespread. Smaller firms and technology-oriented activities show, on the other hand, net employment gains.

1.1.4 Policy implications and stylized facts

A number of policy implications emerge with surprising consistency from the AITEG research efforts, and is broadly consistent with other recent work investigating similar problems, including Vivarelli and Pianta (2000), Fagerberg, Guerrieri and Verspagen (2000), and Petit and Soete (2001). The stylized facts, regarding the impact that innovation has on economic performance and employment, that emerge from this empirical research can be summarised as follows.

1. *Technological unemployment* cannot be neglected as a possible outcome of current technological change, especially in Europe. There is no automatic mechanism ensuring that a national economy is able to fully compensate for innovation-related job losses.
2. *Aggregate demand* and macroeconomic conditions play a key role in creating the conditions for a positive impact of technological change not only on employment levels, but also on income distribution and other consequences of economic change.
3. *Labour market conditions* obviously play a role, as do country specific institutions and social relations. However, there is little evidence that either wage levels or ‘rigidities’ can explain by themselves much of the employment change that has occurred in Europe; on the contrary, structural factors remain crucial.
4. *The sectoral structure* of the economy is important. The sources of job creation and destruction are specific for individual manufacturing and service industries and such structural factors are important determinants of countries’ employment performances. This is particularly important, as the activities based on ICTs and characterizing the ‘new economy’ are highly concentrated in just a few countries.
5. *The type of innovation* is important, with different effects resulting from alternative strategies. Product innovation generally has a potentially positive employment impact, while a negative one is found for process innovation. The overall effect of the technological change recorded in European manufacturing industry in the 1990s has generally been a labour-saving one.
6. *The role of services and ICTs* is crucial. New services and ICT-based activities have a positive impact on growth and jobs, while in other services labour-saving new processes dominate, at least from the limited evidence available for selected countries.
7. *The skill bias effect* is relevant. Within the trend towards a quantitative reduction of manufacturing jobs in Europe, an upskilling process is evident. Blue collar and low skilled jobs have fallen rapidly, while higher skilled jobs have been created, although with a highly uneven pattern across countries, industries and firms.

8. *International production* is associated with innovation and productivity growth. As innovation has an increasingly international reach, a two way link between foreign investment and technological and output performance can be found in multinational firms.

Policy recommendations

Two key principles for policy emerge from such evidence (see also Vivarelli and Pianta, 2000): first is the need for *targeting* the industries with the greater potential for growth and employment, and for specific actions directed at the needs of individual industries; and second is the need for a strong *coherence* between industrial, technology, learning and macroeconomic policies.

There is a strong interaction between technological, structural, demand and learning factors, but the main objectives and mechanisms of policy formulation in each of these fields are contradictory and fragmented, with little positive impact on growth and employment.

In contrast to such needs, current policies, at the national and European levels, have given priority to other issues, resulting in unsatisfactory performances and inadequate adjustment to technological and economic change. Given the limitations of current policies new policy directions that emerge from such evidence can be summarized as follows (as argued also in the concluding policy considerations of Vivarelli and Pianta, 2000).

- i) *A new macroeconomic policy* – needs an active and selective demand policy, providing a coherent context for industrial and innovation policy.
- ii) *Targeted industrial policy* – has to focus on the activities (often ICT-related) with highest growth, network externalities, capacity for learning and product innovations, combining supply and demand measures.
- iii) *Targeted innovation policy* – In order to achieve long-term growth and reduce unemployment, more attention has to be paid to the ability to innovate in technologies, organisations and institutions. Three main aspects can be discussed in this context:
 - a) *Focusing on employment friendly innovations.* Supply-side incentives and funds for innovation should introduce a clear focus on the type of innovative activities more likely to result in new products, rather than in labour-displacing new processes. It should be clear that continuing in a policy of indiscriminate financial support for supply-driven innovation by firms may lead to major direct losses in employment.
 - b) *The potential of ICTs.* There is a mismatch and lack of coordination between the technological, organisational, institutional and social innovations which are required for the

successful emergence of a new technological paradigm. Therefore, attention has to be paid to the social arrangements concerning in particular the role of learning (see below), the use of time and the ways of stimulating the emergence of new activities addressing unmet needs.

- c) *Introducing demand pull policies and focusing on the users.* The development of “demand pull” (as opposed to supply push) schemes “empowering the users”, which might accelerate the development of markets for new goods and services, and also address existing specific social needs.
- iv) *A new learning policy* – a broad view of learning is needed, which avoids the simplistic request for an educational system closer to the short-term needs of firms and includes specific actions for the problems of the low skilled.
- v) *A new distribution policy* -- The distribution of the productivity gains resulting from technological change has to become part of the policy process. Policies need to address not just the achievement of productivity gains made possible by new technologies, but also the pattern of distribution of such gains.

More generally, two additional aspects deserve close attention:

- *Institutional innovations*, consistent with the new nature of technological change, are required in order to reap all the benefits promised by the diffusion of ICTs and to redistribute them efficiently and effectively across society.
- *Appropriate levels for policy actions* are required: actions by national governments need be integrated at the regional, European and global level, overcoming some of the limits of traditional policies implemented in the past.

1.2 Globalization

The globalization studies of the AITEG project focus strongly on issues of the internationalisation of production and production systems and their impact on innovation and performance in accordance with the emphasis of the overall project.

The issues researched in the field of Globalization span the following:

1. Theoretical and empirical analysis of indicators of internationalisation
2. International production and innovation
3. MNCs’ activities and performance
4. Impact of trade on macro performance in the EU

Most studies contain comparative analyses of countries and or sectors. Several are based on specific case studies. The methodologies used range from deductive analysis to examination of large surveys and database to econometric techniques.

1.2.1 Globalization of production

This area of research assesses the impact of internationalization and examines the various forms of global production systems and networks. Research focuses on the spread of activity of MNCs, the impact of foreign direct investments, cross-border mergers and acquisitions, alternative modes of internationalisation, such as strategic alliances, licensing agreements, decentralisation of production and international subcontracting. The idea is that the way international production is organised is most likely to impact on economic performance, although with significant differences across industries and countries.

Theoretical and empirical analysis of indicators of internationalisation

This topic was approached, in the first instance, with an analysis of the theoretical underpinnings behind various indices of internationalisation. Internationalisation has been measured in a variety of ways which mostly identify a firm's 'degree of foreignness', i.e. the quantity of international production that is carried out by the MNEs outside their home country.

In the approach used here, particular emphasis is given to the impact of MNCs' strategic behaviour and its effects on the geographical spread of activities across countries.

The relevance of the impact is seen (a) in relation to bargaining power over other economic actors who do not or cannot plan and organise across countries to the same degree as the MNCs can. Hence actors are labour, consumers, uninternational companies including most SMEs; and (b) in relation to innovation issues such as learning and diffusion of technology.

In this perspective two sets of indicators were developed:

- An index that measures the *intensity* of internationalisation that is the ratio of international activities in relation to domestic activities.
- An index of *extensity* designed to capture the extent to which the activities are spread among many or few countries of the world.

Two sets of indices have been presented and estimated for the largest TNCs with a focus on EU countries and on industries. (1) The internationalization index (Ii) i.e. the ratio of foreign to total subsidiaries. This *intensity* indicator is designed to measure the degree of foreign projection of the company(ies). (2) The Network Spread index (NSi) assesses the degree to which the company's direct foreign activities are spread into many foreign countries or are concentrated into a few ones. This is a measure of the degree of geographical *extensity* of the companies' activities.

Both indices allow some inference on the possible impact of the companies' strategies on national economies, on issues such as: trade structure; balance of payments; possibly domestic investment and employment. Moreover, the degree of network spread of the company's direct activities allows some inference on the following: high costs of managing large direct networks; the spreading of risks by the company as the strategy may be seen as a location diversification strategy; scope for the manipulation of transfer prices which is enhanced by operations in many foreign countries; high bargaining power by the company towards labour and governments; high scope for knowledge spillovers. These may be intra-firm spillovers that is those that are internal to the firm within a single country - in which the company locates its subsidiaries/affiliates (including the home country) - and across many countries. There can also be external spill-overs from the firm and its subsidiaries to the industry and the country in which it operates. The spillover may refer to either technological or managerial knowledge or both.

The results show that the EU as a whole has been involved in a process of deepening of its foreign direct investment activities at both inward and outward levels. Within the EU there are considerable differences between countries. Some are at the forefront of direct foreign involvement both on the inward and outward sides (UK; Netherlands; Belgium-Luxembourg; Sweden); others are emerging strongly (Finland and Ireland) and other exhibit low percentages (Greece; Portugal; Spain; Austria).

The internationalisation index (Ii) for the largest TNCs shows results not very dissimilar from the above at the macro level. The countries with above average Ii have also large and increasing ratios of FDI to GDFCF. On the whole, countries with high (low) Ii exhibit similar pattern for NSi. The main exception is Belgium with well above average Ii in the year 2000 (66.1 percent) and below average NSi 6.7 percent.

The spread of subsidiaries across countries shows high and growing levels of integration by the largest TNCs in the EU. There appear to be a size effect with the largest economies (US and Japan) exhibiting a lower than average foreign projection. This was interpreted as meaning that the large economies allow the companies to reach a large size by domestic activities to a wider extent than is possible in smaller European economies. However, we have also seen that the EU countries have increased their direct involvement within the EU itself.

The industry profile shows the following pattern. (1) Consumer products sectors have high ratios for both indices (Ii and NSi) as companies follow market-seeking strategies and both high foreign projection and high location diversification are relevant for the strategy. (2) Utilities and industries of national relevance in which both indices are rather low indicating the high relevance of the domestic economies for these industries. (3) Sectors in which the low levels of both indices may be due to alternative modes of internationalization (such as trade). (4) Sectors in which the prevalent strategies are resource-seeking ones and which thus exhibit high levels of foreign projection (high Ii index) coupled with a relatively low locational spread (low NSi) as the companies concentrate in relatively few foreign countries.

The case study of the UK largest companies in manufacturing and mining for a 35 years period shows increasing levels of both foreign projection and locational spread among foreign countries. It also shows that the companies that have managed to

survive in the top list for the longest period have higher than average internationalisation levels and belong mainly to sectors characterized by market-seeking strategies of internationalization. This overall result supports the hypothesis of strong relevance of internationalization strategies for growth and survival and of sector-specificity in the strategies.

The impact of international investment

The impact of outward and inward foreign direct investments on domestic employment is examined in more detail in Castellani and Zanfei. The authors tackle the effects of multinational presence on host economies using comparable firm level data with ISIC three-digit sectoral detail, obtained from the combination of Dun and Bradstreet's *Who Owns Whom* and Bureau Van Dijck's Amadeus, Castellini and Zanfei describe the sectoral patterns of manufacturing foreign direct investments in France, Italy and Spain, and relate these patterns to the labour productivity of domestic enterprises in the same countries over the 1993-1997 period. After illustrating these patterns, they examine to what extent domestic levels of productivity are associated with the degree of foreign presence across sectors in the three countries. Although the analysis carried out in this paper is not able to control for all sources of heterogeneity which may affect this correlation - see Castellani and Zanfei (2001) for a different methodology - it does appear that foreign presence is positively associated with domestic productivity in the case of France. It is less clearly so in the case of Italy, wherein a polarised picture can be observed, with groups of sectors characterised by both low foreign presence, and low productivity of domestic firms (as in the case of transport equipment), and other groups of sectors characterised by much higher foreign presence and high domestic productivity (as in the case of food industry). Finally a negative correlation is observed between foreign presence and domestic productivity in the case of Spain, which is particularly evident for values of foreign presence higher than 50%.

National studies on internationalism

Offering an even more detailed analysis of multinational strategies and economic growth, Balcet and Enrietti (2001) adopt a firm-level case study approach. They focus on FIAT as a relevant case of multinational expansion in the Automotive industry, and illustrate its evolution over time from what they depict as a multi-domestic strategy, characterised by subsidiaries serving local national markets as an alternative to exports and licensing, to a regional and global orientation, wherein an intra-group division of labour can be envisaged within and across macro-regions.

A turning point in the transition towards regional strategies occurred in the late 1980s when FIAT started technologically advanced assembly lines in Poland and concentrated there the production of a new car – the new Cinquecento – for the whole European market. Furthermore the decision was taken to set up a new production complex in Argentina, in 1995, which paved the way to the development of a network of specialised foreign affiliates in the Mercosur regional area. Based on these regional networks, centred in Latin America and Eastern Europe, FIAT then developed what Balcet and Enrietti call a focussed global strategy.

The authors are then able to assess the impact of this globalisation strategy in terms of trade flows, of changing firm boundaries and vertical supply relationships, and of employment. As far as trade flows are concerned, their detailed analysis of Istat 8 digit data on foreign trade, and of intra-firm trade data supplied by FIAT itself, highlights a three stage process: first, a strong export flow of parts, components and machinery from Italy to foreign affiliates; second, a decline of component exports from Italy due to growing local content of foreign productions; third, growing imports of components by Italy as foreign units develop.

The impact of FIAT's globalisation on vertical relationships is also striking. In a scenario that is characterised by growing outsourcing processes, higher modularisation of parts and components, and increasing involvement of manufacturers in complementary service activities, supplier relationships are undergoing a deep change as a result of globalisation.

Finally, the direct effect of globalisation on employment can be estimated for Poland, and turns out to be negative as a whole as far as total employees of the local subsidiary of the Italian company are concerned, due to the de-verticalisation process which occurred at FIAT in the early 1990s (employment dropped from 24,427 to 11,532 in 1991-1996 at FSM-FIAT in Poland).

Similar AITEG research focuses on internationalisation of production in the service sector. However any study of services – including those related to their internationalisation pattern – is confronted by the difficulty in conceptualising services and in classifying products, firms and industries within services or manufacturing. The new information and communication technologies have created new products, production processes, industries and modes of delivery for products. They have also strengthened the linkages and complementarities between manufacturing and services products and industries.

Letto-Gilles and Girardone discuss two specific demarcation criteria for services and manufacturing. The first one based on the tangibility/materiality of the product and the second one based on the sectoral contribution to productivity.

Issues of innovation and internationalisation are closely linked to these demarcations. Specifically it can be argued that the new technologies of information and communication are affecting the divide between manufacturing and services; creating new complementarities between products, between production processes and between industries; generating new modes of internationalisation; leading to new products and components; leading to an *electronic-age* 'new international division of labour'. Most of these processes are at the initial stage and they are likely to become more relevant in future years as the diffusion of ICTs and their effects expand.

The results show that in terms of affiliates' presence in host countries, services tend to be less internationalised than manufactured products. The firms in both manufacturing and services sectors appear to follow similar strategies whenever they deal with consumer products.

The overall conclusions are that the new technologies are generating enhanced scope for internationalisation including a new mode: via e-transmission of the products. They are also generating new complementarities between manufacturing and services. There may also be complementarities between delivery modes as for example FDI may follow an initial penetration via electronic transmission of service components. The traditional classification between the three main sectors of the economy and in particular the demarcation between manufacturing and services, may no longer be fully adequate for understanding the features of the economic system: the productivity levels and changes.

1.2.2 Globalisation of technology

The interaction between globalisation and technological change has taken several forms and operates at different levels. Archibugi and Coco (2001) approach the research in this area by analysing the globalisation of technology in the three forms of international exploitation, global generation (by MNEs) and technology collaboration in the industrial and academic world, and draw conclusions about the European gap in the learning economy and to inform policy actions.

The following emerges from the data collected: first, Europe is not at the core of the globalising learning economy, lagging with respect to the United States and Japan on key dimensions of knowledge production as well as in high-tech sectors; second, in spite of the good mixture of competitive and cooperative incentives, the European Commission's policies have not managed to generate a European Union for business R&D. Given that the budget of the European Commission for Research and Technological Development is less than 6% of the total European expenditure, this result is hardly surprising.

Many European firms have a preference to locate substantial R&D and innovative activities in the United States rather than in other European countries. Likewise, they have become keener to sign strategic technological alliances with United States' counterparts than with European ones, probably because of the attractiveness of the size, quality and direction of research carried out on the other side of the Atlantic. Another possible explanation is that US based companies are less likely to be direct market competitors for European companies; third, in apparent contrast with the previous finding, it has also been shown that the European academic community has a stronger and increasing propensity towards intra-European collaborations, while US-European academic collaborations are decreasing. This aspect deserves to be further investigated.

Given this evidence, the authors advocate a stronger coordination at the European institutional level in order to give to the management of knowledge the same attention and authority as the management of money.

Other AITEG research focuses on the impact of technological activities of MNCs. Research in this area focuses on the formal mechanisms through which technological spillovers can occur. As illustrated by studies on different industries, geographical proximity with academic scientists or with high technology activities does not always

stimulate firms' productivity growth and more formal relationships must be developed.

MNCs activities and performance

Other studies focus more directly on national systems of innovation and investigate the internationalization of innovation in industries. Castellani (2001) produces rather robust econometric evidence on the overall effect of Italy's FDIs on internationalising firms' technological trajectories. His idea, which is by and large consistent with the framework outlined by Narula (2001), is that by setting up subsidiaries in foreign countries, multinationals can learn foreign technologies, grasp new uses and applications for their own products and technologies, adapt products and processes to specific needs, and improve their organisational processes as well as their distribution strategies. This should determine an upsurge in technological trajectories, which will eventually translate into higher productivity levels for internationalising firms as opposed to non internationalising ones.

Criscuola and Narula find that the internationalisation of R&D has been driven by a myriad of factors. The most prevalent of these factors are the need to respond to different demand and market conditions across locations, and the need for the MNE to respond effectively to these by adapting their existing product and process technologies through foreign-located 'home-base exploiting' (HBE) (Kuemmerle, 1997) or 'asset-exploiting' (Dunning and Narula, 1995) R&D facilities. However, over the last decade supply factors have become an increasingly important motivation for carrying out R&D activities abroad (Kuemmerle, 1999, Serapio and Dalton, 1999, and Patel and Vega, 1999). With these 'home-base augmenting' (HBA) (Kuemmerle, 1997) or 'asset-seeking' (Dunning and Narula, 1995) R&D facilities MNEs aim at absorbing and acquiring technological spillovers, either from the local knowledge base (public infrastructure or to benefit from agglomerative effects in a specific sector), or from specific firms.

Their findings indicate that HBA activities are now an important aspect of foreign-based R&D in the US and the EU. Firms from both regions tend to use their foreign-based R&D activities to tap into the knowledge base of the other (host) region, with the exception of the chemicals sector. European MNEs however seem not to be able to exploit the knowledge acquired abroad in their home countries, with the exception of the computers sector. Reverse technology transfer appears to be stronger for US MNEs.

Other studies analyze the regional impact of technological and production activities of MNCs. Molero analyses how transnational companies contribute in a distinctive way to the development of the National System of Innovation of each country in which they are active. He concentrates his attention on two contrasting country studies, Germany and Ireland, characterised by different levels of economic and technological development, but both having a relatively high degree of exposure to foreign direct investments. Using CIS data on innovation, Molero highlights factors differentiating the sub-samples of multinationals and domestic firms in the two countries. He finds that multinationals tend to be more integrated into the National System of Innovation in the case of countries (regions) with already high levels of technological

development. This is consistent with a rather extensive literature that has stressed that the capacity of economies to host technological activities of multinational enterprises is related to the advantages they have in specific technological and economic fields (Patel and Vega, 1999, Cantwell and Iammarino, 2001, Cantwell, Dunning and Janne, 2002). Molero also finds that being a member of a group seems to increase the possibilities of having access to intra-firm sources of innovation, and appears to enhance technology transfer and acquisition activities, hence further reducing differences between national and multinational enterprises in this respect.

Cantwell and Iammarino analyze the spatial distribution of both the technological operations of MNCs and overall GDP across EU regions: in spite of the relevance of corporate innovation for economic growth, our knowledge of the locational patterns at the sub-national level is still very limited. This analysis is used to obtain a representation of selected regional innovation systems (RSIs) as a means of illustrating some basic links between technological growth and systemic characters.

The authors map the aggregate technological activity carried out by large multinational firms in the EU regions. In general terms, the geographical dispersion of MNC research is only weakly associated with the levels of economic wealth. Though the impact of national systems of innovation (NSIs) appears to emerge quite clearly from our technological proxy, NSIs are not always homogeneous entities.

The second step was to look at both the technology and economic wealth proxies in terms of growth, i.e. the percentage change of per capita GDP between 1978 and 1995 and the percentage change of US patents stocks between 1969-77 and 1987-95, always standardised to the EU average. To sum up the main observations, a rather remarkable diversity of EU systems of innovation seems to emerge both at the regional and at the national level. The UK, Sweden and Belgium turn out to be, as far as MNC patenting is concerned, relatively homogenous NSIs; however, only the regions of the latter can be identified as both technologically and economically dynamic. Whilst Dutch regions display an outstanding economic uniformity, they are highly scattered with respect to technological activity, with Zuid Nederland being by far the strongest and the fastest-growing RSI, hosting Philips's headquarters which, as is well known, has played a crucial role in shaping the Dutch NSI profile. Germany, Italy and France present a rather dualistic structure, being split between strongly innovative and technologically backward regions. This coincides also with more scattered GDP levels and rates of growth. In Italy, however, the character of the distribution of technological activities largely resembles that of an actual "polarisation" (even taking into account the different NUTS level), confirming once again the continuing huge regional imbalances of the national system.

The analysis gives support to the idea that to treat the NSI as if it was a homogenous socio-economic entity is no longer feasible. Our results have preliminarily indicated that the regional concentration of MNC technological activities seems to have increased over time, and that the risks of assuming homogeneity increase as the gap between the most technologically advanced RSIs and both backward regions and less dynamic innovation systems has become wider.

1.2.3 Policy implications

Internationalization strategy

Four main sets of results have implications for policies. First, the relevance of internationalization strategies and sector-specificity for survival among the largest and thus for overall company size and growth. Second, the relevance of the size of the domestic economy for the degree of internationalisation with larger economies appearing to have TNCs which are less involved in international strategies. Third, the evidence that the EU largest TNCs are contributing to a large and growing degree to the process of European integration. Fourth, the sector-specificity of the pattern of internationalisation both in relation to the degree of foreign projection and in relation to the degree of international locational diversification (NSi). The pattern is also, to a large extent, country specific.

All these result together have the following implications for policy. The integration process within the EU is spearheaded by the largest TNCs and is also in their interest in terms of size of the market. The extent to which companies originating from EU countries will be encouraged and sustained in their internationalization strategies has to be closely linked to their sector-specificity. This means that internationalisation policies must be seen in the context of industrial policies for Europe.

It has been suggested that a strategy of international locational diversification gives strong advantages to companies in terms of risk spreading and in terms of the acquisition of strong bargaining positions towards labour and governments. Some problems derive from the fact that truly transnational institutions that plan, organise, and control resources and activities across different nation-states, face actors which for historical reasons or by their own nature are not (or not yet) able to operate across countries to the same extent. The policy implications here are that governments should follow policies of enhancement of countervailing transnational power among those actors who are still lacking such power, for example labour, consumers and uninational companies, particularly SMEs.

The spreading of activities in many countries may generate problems for labour and governments as well as some extra costs for companies; however, it may bring opportunities for knowledge spill over of an intra-company as well as external ones.

Internationalization and services

The new technologies are generating strong specificity for services in both the innovation and internationalization fields and indeed even more in the interface between the two. This means that we can no longer use for services the conceptual frameworks developed for manufacturing. Accordingly, more research is needed on the sources of productivity growth in the economy and on the impact of the ICTs on: productivity; internationalisation processes, modes and degrees; and the impact on the international division of labour.

There needs to be more utilization of skilled labour in developing countries for work on electronic transmissible products requiring relatively little physical infrastructure

and high level human infrastructure. The EU countries might consider investing more in the education of young people in developing countries. Encouraging their employment *in loco* on services – or part of the services production process – organised from developed countries. The services may be organised by the private but also the public sectors.

There is also a need to develop statistics that take account of the ICT-intensity of products and processes on the industrial classification side. While on the side of international data we need statistics on the various delivery modes including the electronic ones.

2. Background and objectives of the project

The European countries have been plagued for the better part of three decades with persisting unemployment and slower growth than that achieved in previous periods and relative to other industrialised countries. This sluggishness has been occurring against a backdrop of rapid technological change and internationalisation of production that has increased the competitive pressure on EU economies and warrants the need for new policy initiatives.

The academic literature and public policy debates have provided a number of explanations for Europe's disappointing economic performance but two of the major reasons have rested on the twin processes of innovation and globalisation. The mechanisms through which these processes impact employment and growth serve as the major focus for the research papers conducted for this project.

The original objectives of the project as laid out in the proposal were to investigate to what extent the different forms of globalisation of production and technological change have affected the aggregate growth rate of the economy, job creation and job destruction patterns, and the main sectoral developments; and comparing the case of the EU economies with those of the US, Japan and other advanced countries. These objectives were carried out by bringing together detailed analyses of innovation and globalization, assessing their impact on growth and employment using common methodologies and data sources and developing policy perspectives based on the main findings.

Given the breadth in scope of this area, six research themes were proposed and developed in the research for the project:

1. Slow growth, unemployment and the role of technology and globalisation
2. The impact of technological change
3. The impact of the globalization of production
4. The globalization of technology
5. Assessing the overall effects of innovation and globalization
6. Policy perspectives

Research conducted within Theme 1 reviews the performance of Europe and other advanced countries, using macroeconomic and sectoral data. The role of technology and globalisation are identified and the appropriate theoretical and methodological tools are developed for the analysis.

Theme 2 investigates the economic and employment effects of specific innovation patterns, including the distinction between product and process innovations for the manufacturing and service sectors.

The economic and employment effects of the particular forms taken by the emergence of global production systems and networks are analyzed in Theme 3. This includes the role of MNCs, foreign direct investment, cross-border mergers & acquisitions, decentralization of production and international subcontracting.

The interaction between globalization and technological change are addressed in Theme 4. This interaction has taken several forms, influencing the pace and nature of both processes. A review of the main patterns are confined to specific studies of the impact of technological activities of MNCs

Theme 5 brings together the results of the research on globalization and technological change. In the original proposal it was expected that the direct and indirect effects of different aspects of globalization and technological change would be assessed at the firm and/or industrial level. Due to the lack of micro-level data for all countries the analyses is performed at the aggregate level. This level of analysis still makes it possible to maintain the proposed objective and to show how much growth and employment in Europe have been increased or reduced by technological change and globalization.

Finally in Theme 6, policy perspectives are developed based on the main findings in the previous themes. The findings will make it possible to point out which specific forms of innovation and globalization have positive or negative consequences in terms of growth and employment, and policy considerations will therefore be developed for innovation, for globalization and for employment, at the level of European, national, and regional actions.

3. Scientific description of the project results and methodology

The research on assessing the impact of globalization and technology on employment and growth is carried out based on the research themes described in the previous section. There are a number of issues researched in each theme and the studies are subgrouped around these issues. The project results and methodology will be reported in this section following these subgroupings.

3.1 Slow growth, unemployment and the role of technology and globalization

3.1.1 Slow growth, unemployment and the role of technology and globalization: an overview of the evidence and research questions

Unemployment has remained at relatively high levels across most European countries for a generation now. There have been a number of suggested explanations for this, with correspondingly different policy implications. Two of the major hypotheses relate first, to the impact on the European economies from increased international competition and ‘globalisation’ more generally, and secondly, to the effects on new technology and innovation. The evidence on technology and globalization in relation to the economic performance of Europe and other advanced countries was originally presented in AITEG Working Paper 1 entitled, *Slow Growth, Unemployment and the Role of Technology and Globalization: An Overview of the Evidence and Research Questions* and has subsequently formed the basis of articles in the special issues of two journals, the *Journal of Interdisciplinary Economics* and the *International Review of Applied Economics*.

Technology, employment and growth

The literature on technology and employment is discussed in an article by Michie, Oughton, and Pianta [10].¹ This background article reviews the present state of the innovation literature and discusses the AITEG research in that context. The authors also address the myriad challenges confronting economic research in this area, among them the difficulty in developing measures of innovation in the same way as other economic variables. Scholars have had to use ‘partial’ measures, such as R&D and patenting, in order to describe the rate and direction of technological change. However they account for some inputs only (expenditures for research) or for some outputs only (that recorded by patents) of a much wider and more complex innovation process. This inadequacy is strikingly evident when innovation in services is considered: in contrast to their rapid pace of diffusion, only around a quarter of the R&D performed in the business sector is carried out in service industries, and the share of patents obtained by services is below 15 per cent.²

¹ Numbers in brackets refer to references for articles in Section 5 of this report.

² For a discussion of the various possible measures of, and proxies for innovation, see Michie (1998). This is the introductory essay for a Special Issue of the *International Journal of the Economics of*

Moreover, the traditional technological indicators were associated with a rather simplified 'linear' view of the innovation process, leading from research inputs to innovation (and patenting) outputs and to market performance. A more sophisticated 'chain-linked' model has provided a suitable alternative for grasping the systemic nature of the innovation process, increasingly made of a complex web of linkages and knowledge flows between firms and the wider institutional context in which they operate. The concept of 'national systems of innovation' has also asserted itself as an essential part of the picture for studying country patterns and the links between technological change, economic structures and institutions in particular countries. In this line of research the entire economic system is paramount to a country's innovative capacity. Innovation does not take place in a vacuum, but rather is dependent upon the financial, educational, and economic institutions of the country.

Following this line of thought, Corley, Michie and Oughton [1] examine in more detail the impact of technology on economic growth in 8 OECD countries and the United States. The theoretical foundation of the study is based on the endogenous growth framework of Romer (1986), which explains economic growth as being effected not only by tangible investment but also intangible investment, such as R&D. Romer (1986) postulated that R&D leads to the creation of knowledge that can have a direct effect on technological change and in addition, because investment in R&D can create spillovers, it also has positive externalities that can generate productivity gains. Further research has shown that even when both tangible and intangible investment factors are taken into consideration there are still differences that can account for cross-country differences in productivity. Hall and Jones (1999) found that these factors can be institutional and relate to differences in social structure, which affect the economic environment and the ability to acquire skills and accumulate the different forms of capital investment.

Taking these factors into consideration, the study by Corley, Michie and Oughton examines the effects of different types of investment—in the form of physical capital, R&D and human capital on productivity growth in high and low-tech manufacturing industries. The variations in these three forms of capital explain a lot of the variation in productivity growth. However, in addition to investment, industry growth and productivity is also dependent upon country specific factors such as industrial and social infrastructure. The empirical analysis takes this into account by estimating a fixed effect model that captures the differences in productivity across countries. The results suggest that estimating the effects of these three forms of investment without taking into consideration the fixed effects will produce biased results.

The conclusions of the study are that investment in broad capital - physical capital, R&D and human capital - is essential for high productivity in all industries. In both high and low tech industries, Europe needs to raise the level of investment in tangible and intangible capital per unit of labor employed. But particularly in the high tech industries - where there are greater possibilities to increase both productivity and

Business on 'The Internationalisation of the Innovation Process'. It also therefore discusses the relationship between technological innovation on the one hand, and the continued importance of national systems of innovation on the other.

employment – raising the level of investment is likely to show positive returns, especially if it includes appropriate investment in R&D and human capital.

Globalisation, employment and growth

The current globalisation literature considering the key issues underlying the empirical work and theoretical discussion is discussed in Michie, Oughton and Ramirez [11] and Michie, Oughton and Zanfei [12].

Michie, Oughton and Ramirez investigate the impact of the rapid growth in globalisation, by exploring the factors underlying the growth in inward FDI in Europe and the United States and its effect on employment and growth. The theories used to explain the impact of FDI are outlined in the paper and empirical evidence is presented based on patterns of industry employment and productivity growth in the affiliate countries. The paper outlines three strands of literature regarding FDI in developed countries: cost-based stock theories and stock market theories, transaction cost theories and monopolistic advantage and oligopolistic interaction. All of the theories are consistent with the possibility of increased employment as a result of FDI, although in principle the employment effects could be either positive or negative. What is clear is that the employment effects of greenfield investment are likely to be greater than those arising from international mergers and acquisitions (M&A), especially as restructuring is a common motive for M&As. It is also the case that the employment effects are likely to be greater when governments offer financial and other incentives to foreign firms to invest in new capacity. This explains why governments, such as the UK, offer various inducements, including investment subsidies, to large multinational firms. It is important to note that the policy stance adopted by governments in Europe implies that there is a presumption that FDI has a positive impact on domestic economies. If this were not the case it would not make sense to encourage FDI both by removing controls and by offering inducements/subsidies targeted at foreign firms. This raises a number of questions as to the consistency and effectiveness of these policies.

On the one hand, governments in Europe are encouraging M&As by removing restrictions on financial capital flows. The rationale for such a policy would appear to be that it would lead to greater efficiency. There is little empirical evidence from studies of M&As to support this idea. Moreover, given that the motives for M&As include restructuring and elimination of competitors, the effect of such M&A activity on employment is quite likely to be negative. On the other hand, governments have offered financial incentives and subsidies to encourage foreign direct investment in order to create employment. Foreign firms are better placed to extract such subsidies from governments because they can more credibly threaten to locate abroad. However this raises the question of whether subsidies are best targeted at foreign rather than domestic firms. Here it should be noted that governments across Europe, Japan, and the US have adopted different policy stances towards inward FDI.

Looking at the empirical evidence we can determine the relationship between FDI, M&As and employment growth in Europe and the US. Cross country differences in foreign ownership are significantly explained by industrial policy towards FDI. In the

UK, where the incidence is quite high, there is a policy of encouraging FDI by offering significant incentives. While in Germany and Japan where the incidence is very low industrial policy is focused more on domestic rather than foreign firms.

A number of factors make it difficult to assess the impact of FDI on total employment, mainly because it is impossible to separate out investment in greenfield sites—which displaces employment growth by domestic firms. In an attempt to assess the impact of foreign ownership on employment growth we focus on the relationship between the extent of foreign ownership and the rate of growth of employment across sectors and countries.

The theoretical literature reviewed suggests that this relationship may be positive or negative. If foreign owned firms are more efficient and dynamic than their domestic counterparts because they can exploit cost differences across countries and utilise intangible assets more fully then employment growth should be higher the higher the level of foreign ownership within countries and sectors. Productivity growth should also be higher in industries with higher levels of foreign ownership. Alternatively foreign ownership may reflect monopolisation of an industry or restructuring associated with international M&As. If this is the case, it is unlikely that foreign ownership will be associated with higher employment growth, while the effects on productivity growth could be positive or negative.

In general the data indicate that the rapid increase in inward FDI in the manufacturing sectors of the world's largest developed economies and the associated wave of international M&As have been neutral with respect to employment growth. One of the factors behind the neutrality of the effect of foreign owned affiliates on employment growth is likely to be the growth in M&A activity and associated restructuring. If this is the case, the employment effects may be neutral but host economies and sectors may benefit from higher productivity growth. This possibility is explored with data on the relationship between the degree of foreign ownership and the rate of growth of labour productivity for the US and major European economies. The data show that the relationship is fairly flat.

Thus, the evidence suggests that inward investment has no effect on raising employment or productivity growth. The policy implications for this are that policies to attract multinationals through both deregulation and financial and other inducements may be displaced.

Further to this effect, the review article by Michie, Oughton and Zanfei stresses that the effects of globalisation depend on both the activities of multinational companies, and on public policy. Additionally, they emphasize that there is a difficulty in assessing the effects of globalisation on employment and growth because of the myriad data issues. Despite being an important area of academic research with clear policy implications at both the corporate and governmental levels, there is not yet a great deal of internationally comparable, time series data. Indeed, the need for data work was one of the motivations behind the 2000-2002 AITEG project, one outcome from which has been a much more comprehensive and comparable data set than was previously available.

The Community Innovation Survey has provided some useful data, as reported and discussed in research by Hesselman [6] and Cox, Frenz and Prevezer [2]. Modelling the effects of globalisation and innovation on employment is clearly difficult. As several of the papers in the AITEG project illustrate, the effects will depend on corporate strategies and decisions that simply cannot be predicted. In part these will depend in turn on public policy and other factors that are equally unknowable in advance. However, the research by Tancioni and Simonetti [13] does demonstrate the way in which such impacts, from the global economy and from innovation, can be introduced into a model of the economy in a way that not only helps analytically to think through the causal mechanisms, but can at least indicate what the impact might be of different policy actions and changes in corporate strategies in the future.

3.1.2 Investigating the effects of technological change and globalization: theory, methodology and common analyses

Few economists would object to the notion that knowledge is at the root of economic growth. A substantial part of this knowledge takes the form of technologies associated with economic and social activities, such as the production and use of goods and services. For firms, the possession (and sometimes ownership) of a particular knowledge (often embodied in machinery, always present in its workers) is a precondition for carrying out production. The present form of capitalism in advanced countries has often been referred to as a 'knowledge-based economy' and the growing importance of developing and enhancing such knowledge in people has led to concepts such as the 'learning economy' (Archibugi and Lundvall, 2001).

Mainstream economic analysis has made substantial efforts to pay attention to such developments. The new growth theory has started to conceptualise innovation as an endogenous process and variables accounting for technology, learning, and education appear with increasing frequency in models used for empirical tests. However, the paradox is that the fundamentally disequilibrating nature of technological change introduced by particular firms is usually treated in a context that still assumes general equilibrium of markets and undifferentiated economic agents.

The neo-Schumpeterian and evolutionary approaches to economic change have offered, in the last two decades in particular, a solid alternative for investigating the nature and impact of technology. Cornerstones of this approach have included the concept of techno-economic paradigms, linking waves of technological changes to economic and social structures and to institutional setting (Freeman *et al.*, 1982, Freeman and Soete, 1987, 1994); an evolutionary view of microeconomic change characterised by processes of diversity generation (through innovation) and selection (in the marketplace) (Nelson and Winter, 1982); and a link to macroeconomic theories of structural change, cumulative growth, and institutional regulation (Dosi *et al.*, 1988).

Much of this line of analysis puts at the centre of its research the concept of innovation, that is the deliberate activity by firms and institutions to introduce new goods and services and new ways of producing, distributing and using them. A major problem with innovation has long been the impossibility of measuring it in the same way as other economic variables. Scholars have had to use 'partial' measures, such as

R&D and patenting, in order to describe the rate and direction of technological change. However they account for some inputs only (expenditures for research) or for some outputs only (that recorded by patents) of a much wider and more complex innovation process.

Moreover, the traditional technological indicators were associated with a rather simplified 'linear' view of the innovation process, leading from research inputs to innovation (and patenting) outputs and to market performance. A more sophisticated 'chain-linked' model has provided a suitable alternative for grasping the systemic nature of the innovation process, increasingly made up of a complex web of linkages and knowledge flows between firms and the wider institutional context in which they operate.

The Community Innovation Survey

Many of the conceptual and data constraints that have long forced innovation into a 'black box', off-limits for economic research, are now disappearing. New theories are filling the gaps between the understanding of technological change and the functioning of economies; data shortages are replaced by opportunities. For the first time, a large data set on innovation is becoming available for a large number of countries with extensive information on the characteristics, objectives, nature, quality, expenditure and economic impact of the innovative activities carried out by firms. This is the result of the decision by Eurostat and the European Commission to adopt innovation surveys as a systematic source of information on technological activities in firms. The data collected by the Community Innovation Survey referring to the years 1994-96 (CIS 2) can now be linked to the previously used technology variables and to standard economic indicators.

A first new theoretical challenge questions the idea of the homogeneous nature of innovation carried out in firms. Not only the theories of neo-Schumpeterian and evolutionary approaches, but also the rich evidence of innovation surveys now suggest that different models of innovative activities are present, and characterise particular sectors or national economies. An obvious cleavage to be expected is the one between innovation strategies aiming at either product or process innovation. But more refined typologies are also clearly emerging.

A second challenge questions the idea that innovation has an automatically positive impact on economic performance. Again, careful theorising, and now also empirical studies, have suggested that different innovation strategies, which characterize particular sectors, may have diverse effects on economic growth and employment patterns, and on the associated developments in international investment and production.

A third challenge is to integrate the new view of innovation in macroeconomic relations within the complex interaction of demand and supply, the web of substitution and compensation effects, and the turning points in structural change and distribution patterns.

Finally, cutting across all the above issues, there is the need to address in parallel questions at the level of firms, industries and the aggregate economy. The ability to

provide a coherent picture of change at all these levels of analysis remains a challenge for both theory and empirical studies.

Models of techno-economic change

The need to understand the variety of innovations, the diversity of their possible effects and their complex links to macroeconomic issues is made more urgent by the current emergence in advanced economies of the new techno-economic paradigm based on Information and Communication Technologies (ICTs). The questions for theory and empirical research lead in this context to a set of policy options of great importance to European economies.

The radical change in the nature and trajectories of innovations produced by the new techno-economic paradigm is at the core of the latest, short-lived fashion in economic studies and policy, namely the infatuation with the 'new economy' (OECD, 2001). Economic developments during 2001 in the US and the world economy proved that the widespread expectations of continuing rises in stock prices, in the rates of growth of GDP and productivity, and of an 'end of business cycles' to be massively exaggerated. The flop of the 'new economy', however, does not mean that change stops. Rather, it is likely to follow the more complex, long term route of diffusion of a new techno-economic paradigm shown by the history of the emergence of new pervasive 'technological systems' with large potential for change. Sustained and sustainable growth can be expected only once the mismatches between the new technologies and the old economic and social structures and institutions are overcome, in a two-way adjustment of the latter to the requirements of new technologies, and of re-orienting innovation and adapting it to social needs and economic demands.

From our perspective, the most important implication is the possibility of different models of innovation, depending on the constraints posed by existing economic structures, on the competencies available, on the specific strategies pursued by firms and governments. In a very simplified way, four possible innovation models can emerge, relevant for both analysis and policy.

1. *ICT focused.* In this model, innovative efforts are concentrated on the activities based on ICTs and on their applications. The technological opportunities of ICTs are the driving force of growth, although operating from a rather narrow base of technological and economic activities. The ability to extend their impact and applications across a wide range of economic activities is a key test for success.

2. *Learning based.* Here the key process shaping technological and economic change is the learning activity by people and organizations. In the place of technology-driven growth, change is shaped by the evolution of competences, by the upgrading of economic activities, production organization and human skills, and by more complex social processes related to specific economic and social priorities. This is likely to lead to different qualities of economic growth and an improved quality of employment.

3. *Product innovation based.* In the firms and industries with well established markets the opportunities of technological change can lead to a strategy based on the introduction of product innovations and the expansion of new markets, often

integrating applications of ICTs. This can represent a dynamic reaction to competitive pressure, leading to growth in both production and employment.

4. *Process innovation based.* This model applies to the more traditional sectors of the economy, where the pressure from competition leads to a search for cost cutting and process innovation. Such a course is likely to lead to restructuring of firms, concentration of industries, modest growth and large job losses.

Each of these models is associated with different types of innovation and with different consequences for economic and employment outcomes. Moreover, they interact with a set of other processes affecting the sources of innovation in knowledge and learning; the global reach of technological change; the link with the economic structure and with the demand side.

Globalisation

The current literature and evidence on globalization was originally presented in AITEG Working Paper 2 entitled, *Investigating the Effects of Technological Change and Globalization* and is summarized here.

In the Hecksher-Ohlin (H-O) model of international trade, where each country exports the goods in which it holds a comparative advantage, the effect of globalization on employment is the following: as trade and capital flows increase, an economy with higher labour costs will increase its share of production in those sectors with lower labour intensity. Introducing technology into the Hecksher-Ohlin model, by including it as another factor of production, yields two alternative results. Firstly, globalization tends to decrease the technological differential across countries because larger trade flows and higher capital mobility stimulate the international diffusion of innovation³. Secondly, the increase in the volume of trade and capital flows between developed countries and less developed countries increases demand for and real wages of skilled labour and decreases demand for and real wages of unskilled labour in developed countries. Introducing technical progress directly into the traditional two factors-two commodities theory, each sector exhibits different dynamics of output and employment, due to the interplay of different technological opportunities and demand patterns; and the cumulative nature of technological progress causes a lock-in of sectoral specialisation, and a specialisation in innovation⁴. Given these two effects, one cannot expect that the process of structural adjustment necessary to restore full employment will be spontaneous. Therefore, we need to understand the determinants of country-specific technological advantages and their interplay with globalization to assess growth and employment outcomes.

³ This theory was opposed by Jeffrey Sachs in the *Economist*, 19 June 2000; in his article, he argues that the most important dimension of globalization is that of technology, and he asserts that the world is becoming more and more polarized in terms of access to this technology. See also Archibugi and Michie 1995.

⁴ We will come back to this in the section on national systems of innovation.

Additionally, a crucial point that has received only slight attention in the literature is that the effect of trade on employment is not static and depends on developments at the level of the firm, e.g. managerial attitudes. The X-efficiency literature offers an explanation of why increased import competition might lead to managerial actions that raise labor productivity and reduce employment. The idea is that given some rent-threatening disturbance, such as increased international competition or a shift in corporate control, managers take actions to increase efficiency by eliminating excess labor or possibly by introducing labour-saving techniques that were not fully exploited prior to the competitive disturbance. This analysis still needs empirical verification.

As suggested, the impact of trade on employment works both directly and indirectly through changes in wages, a more focused analysis of the impact of trade on wages is necessary. The classic theoretical piece on international income distribution with trade, the factor price equalization concept (Stolper-Samuelson, 1941) asserts that when a country in which highly skilled labor is abundant trades with a country where skilled workers are scarce and unskilled workers abundant, the wage rates of skilled workers across the world tend to converge, as do those of unskilled workers: the wages of skilled workers rise in the rich country and fall in the poor one, while the wages of unskilled workers do the reverse.

The role of foreign direct investment

From a positive perspective, on the question of inward FDI, firms point to the increased demand by their subsidiaries for domestically-produced intermediate products and capital goods, as direct foreign investment takes place, hence the positive impact of supplier networks on employment. It can be argued that external control may produce several other benefits. Evidence from Scotland shows that when employment performance of new foreign-owned plants is separated from that of all other new openings, the evidence is probably more favourable to the externally-controlled sector. McNie (1983) finds that not only did overseas plants in Scotland reveal a better overall employment record than indigenous openings, but this difference persisted even after allowance had been made for differing industrial structure of overseas incomers and relatively larger average plant size which they displaced. Ashcroft & Love (1993) also find that the external sector and particularly new foreign-owned plants has made a significant positive contribution to job creation in Scotland and probably elsewhere in the UK.

Other studies have been rather pessimistic, particularly when it comes to the analysis of outward FDI. First, on the issue of outward FDI effects, Frank and Freeman (1978) derive substitution parameters indicating the ratio of the quantity of goods each industry would supply in the foreign market if it only exported to this market compared to the quantity it would supply in this market if it did not export but produced these goods in its lower cost foreign facilities. In other words, they conceive of foreign investment as an alternative to trade. The direct and indirect number of jobs displaced by this loss of exports is calculated from the 1970 input-output table and appropriate labour coefficients. They find a net number of jobs displaced by U.S. foreign investment in 1970 of 160,377.

A more neutral perspective is that of Messerlin (1995). Unlike Frank and Freeman, rather than seeing FDI as an alternative to trade in terms of employment creation, Messerlin (1995) views them as complementary, which helps us conceptualize globalization as a whole. Indeed, apart from his analysis of trade above, he finds that direct foreign investment by French firms is concentrated in industries in which trade changes have brought about job gains rather than in those sectors that experience job losses through trade. He also finds that job-contracting industries do not invest in the rest of the world more than others, and tend to receive foreign investment as much as others, so that neither inward nor outward FDI as such have an effect on industry-specific job destruction.

Although these two pieces of evidence emphasize outward FDI as an employment destructor or at least a preserver of the status quo, it would seem that in any analysis of the net effects of FDI on employment, the losses in employment from the country's FDI abroad must be contrasted with the potential gains in employment from foreign FDI in a country. On the issue of inward FDI, although Glickman and Woodward (1989) find that the number of employees of US affiliates of foreign companies increased by about 547,927 between 1982 and 1986 (they find employment changes are due to new plants (+45,151), expansions (+341,281), *acquisitions* (+1,381,690), cutbacks (- 442,295) and sales and liquidations (-777,900)), behind the rosy general picture, most of the almost 1.4 million job gains under the acquisitions category merely represent the transfer of existing jobs from domestic to foreign owners. The authors believe that liquidations of assets are more likely to lead to net job losses, because they are not able to separate the sales and liquidations component, they cannot evaluate the loss of almost 0.8 million jobs cited in the sales and liquidations component. Returning to the net effect of inward and outward FDI, Glickman and Woodward find that for the US, any gain from inward FDI is less than the number of jobs lost by direct investment abroad by US firms.

The special case of acquisitions

Given that 85% of FDI is conducted in the form of mergers and acquisitions (M&As) it would prove informative to analyse its effects on employment and growth separately. Ingham, Kran and Lovestam (1992) find that there is a predominance of horizontal mergers now, which suggests a consolidation of a major line of business and/or the pursuit of market power. Profitability is shown to be one of the three most important reasons for mergers, and the most important factor when selecting a target is the nature of the target company's operations.

Indeed, if unemployment is created by M&As, it is also interesting to determine if there is a trade-off between unemployment and increased efficiency. According to Herzel and Shepro (1990), there is no evidence that takeovers have improved efficiency of US industry. If managers know that they are likely to lose their jobs in a hostile tender offer, they will try to manage their companies to move stock prices up immediately; this causes companies to focus on the short-run.

The Massachusetts Institute of Technology (MIT) Commission on Industrial Productivity therefore concludes that 'the wave of hostile takeovers and leveraged buyouts encourages excessive overvaluation of short-term stability' (Herzel & Shepro,

1990). This leads them to compare Japanese and European executives with US executives. They find that the former are less preoccupied with earnings, dividends and stock prices, and that they show greater concern for their employees.

Schreyer (2000) distinguishes between internal and external growth of firms. External growth comprises in particular mergers and acquisitions – a phenomenon that occurs almost exclusively among firms of a certain age. For Schreyer, “if two firms of a certain age merge, and if the measure of firm growth comprises external growth, there will be a statistical occurrence of a high-growth firm. However, no new employment has been generated. Thus from an employment perspective, an analysis of internal growth only is useful”. Schreyer looks at the case of Sweden and concludes that:

- First, only about one-third of all employment gains by high-growth firms are internal growth: two thirds of employment gains are in high-growth firms that grew fast as a consequence of mergers and acquisitions.
- Second, when employment gains are restricted to internal growth, the age profile of high-growth firms becomes very accentuated and nearly all of the contribution to employment gains comes from young firms as acquisitions are concentrated among older firms.

Thus, we find internal growth mostly in young firms, which are seen as employment creators; we find external growth mostly in old M&As, which are not seen as employment creators.

Williamson (1987) asserts that certain mergers yield economies at the same time as they increase market power. With a very simple model, he shows that a merger, which yields nontrivial real economies, must produce substantial market power and imply large price increases for its net allocative effects to be negative. However, the cost savings required to offset price increases are significantly greater if pre-merger market power prevails, and of course among those cost savings, real wages are included. Williamson supports Schreyer’s idea that internal growth could be more allocatively efficient than external growth. Last, on the impact of M&As on technological progress (which is key for our study) and continuing on the small/large firm merger debate, Williamson finds that it seems unlikely that subsequent investigation will upset the basic proposition that progressiveness is promoted by at least some elements of competition at virtually every stage of an industry’s development. Monopoly, or near-monopoly would not seem to be the best instrument for technical progress in industries for which the relevant market is national.

Extending this to a discussion of size, Williamson finds that small-sized firms rarely have negative effects on progressiveness, but it is mainly in relatively large firms, that the effects of a merger on technological progress deserves special concern. More importantly, Williamson’s point highlights the fact that in particular the cross-border M&A is a highly important actor at the crossroads between the globalization and technology debates, in that it has particular implications for both; this form of investment is a bounty for researchers trying to tie up the globalization and technology questions, and an ideal target for empirical investigations.

The analysis of M&As and of their impact on employment also depends on the theory of the firm. For instance, Penrose defines the firm as an “autonomous administrative

planning unit, the activities of which are interrelated and are coordinated by policies which are framed in light of their effect on the enterprise as a whole” (Penrose, 1959). Investigating the growth of the firm, Penrose claims that the “capacity of a firm to alter its administrative structure in such a way that non-routine managerial decisions requiring real judgement can be made by large numbers of people within a firm without destroying the firm’s essential unity, makes it difficult to say with confidence that there is a point where a firm is too big to be efficiently managed” (Penrose, 1959). Symmetrically, the attainment of a ‘state of rest’ in the firm is precluded by obstacles arising from familiar difficulties posed by indivisibility of resources, from the fact that the same resources can be used differently under different circumstances, and in particular in a ‘specialized’ manner, by obstacles arising because in ordinary processes of operation and expansion new productive services are continually being created.

One of the cornerstones of economics is specialization of resources, but specialization of resources is limited by total output of the firm, for the firm's output controls its demand for productive services. Specialization yields the higher common multiples with respect to output which will fully use specialized services of resources acquired, and this in turn will push for greater specialization. However, during the growth process, the firm changes so much, that its management no longer has much in common with that of a small or medium enterprise. Though the grown firm keeps its initial identity, this identity cannot survive complete absorption in an entirely different administrative framework; this ties in directly into the M&A discussion, in that it implies acquisition necessarily “creates” a new firm, hence the idea of external growth. In that sense, a new firm means new resources, so that it is not valid to consider employment of workers as the measurement of the labour resource, and then look at it before and after a merger, given that the firm and its resources are new. We are talking about a new firm, and longitudinal analysis cannot be applied.

Healey (1982) and Leigh and North (1978) found a significant number of closures in Scotland following external takeover, particularly horizontal acquisitions. Smith (1979) compared the employment performance of externally-acquired manufacturing plants in the Northern region of the UK with both those controlled from within the region and from outside the region since 1945. He calculates ‘closure quotients’ and employment loss due to closure. The externally-acquired quotient is markedly higher.

Conversely, Hood *et al.* (1981) report favourable employment effects associated with acquisition. From interviews with a sample of twenty-five European affiliates in Scotland, which included fourteen that had entered by acquisition, they found that the expected employment change over the period 1980-84 of those entering by acquisition was greater at 34.8% than those entering by new ventures, where a 21.9% growth expectation was reported. The authors argue that the most likely explanation for this is the advantages from relatively low cost entry via an operation with an established labor force, products and markets which provides a platform for accelerated expansion. However, it is difficult to generalise about the effects of external control, and particularly external takeover, in the crucial area of employment.

Cartwright and Cooper (1992) find that M&As are associated with high levels of staff turnover, which suggests that the effect of the M&A form of FDI does not differ from other forms or from trade for that matter, in that it would also cause the decrease in employment of unskilled workers, which we conjectured above. The negative impact

of M&As on employment, apart from voluntary resignations, which constitute the psychological impact of M&As, other reasons are economies of scale, rationalization and the replacement of a substantial number of employees that did not 'fit in'.

The methodology of research on the impact of innovation and globalization

In order to investigate the effects on employment, the links between the innovation process, globalisation, the economic structure, the forms of competition and demand need to be examined. The transformations on the supply side, brought about by the innovative activities and the investment patterns of firms cannot be simply seen as technology-driven developments. Rather, a key role is played also by the demand side, with the aggregate dynamics of consumption, investment and exports, by the sector-specific patterns of change and particular market structures. On top of these economic factors, the outcomes of technological change and globalisation are associated with the institutional setting, social arrangements and a broad interplay of social relations.

In investigating the impact of innovation we have to point out that technological change leads to a variety of innovative strategies of firms, associated with particular competitive strategies in given markets. In parallel, aggregate and industry demand emerges in particular market structures with given forms of competition. The economic and employment performance of firms results from the interaction between such technological and demand factors; the performance of industries is more directly constrained by sectoral demand dynamics. A few issues emerge as critical in affecting the employment outcomes; they include the type of innovative strategy (dominated by either product or process innovations), the dynamics of demand, and the level of the analysis (firm or industry level).

Technological change creates industry-specific opportunities for innovation in firms; firms' strategies can neglect them, or turn them in different directions. A key distinction here is that between a strategy based on process innovations (introduced mainly through new investment) and the search for product innovations (based on internal innovative activities as well as on new intermediate or capital goods). Such a distinction is essential because they contribute in different ways to the process of technological change. Process innovations lead to improvements in the efficiency of production of particular goods and services, while product (or service) innovations - either incremental or radical - increase the quality and variety of goods and may open up new markets, when the replacement of old products is not the dominant pattern within product innovations. They have, in general terms, contrasting employment effects: increasing productivity and replacing labour in the case of process innovations; creating new markets, production and jobs in the case of product innovations. Obviously the distinction between process and product innovations should not be brought too far. In some cases, especially in services, the two are closely interlinked, and in the case of the introduction of radically new products, innovations also in processes are usually required. Thus, there is a degree of complementarity between the two that should not be ignored, but in most firms and industries it is possible to identify the dominant orientation of innovative efforts.

The need to assess the specific nature of innovation does not stop at identifying the dominance of new products or processes. It requires consideration for the specific

activities undertaken by firms, beyond the traditional reliance of economic analysis on R&D or patenting indicators. The recent results of the European innovation surveys show that "disembodied" innovative efforts go much beyond R&D and include a variety of activities, such as design, trial production, exploratory marketing, and the acquisition of new knowledge and skills. In addition, innovative activities "embodied" in new equipment and machinery can now be identified with greater precision. The result is that in some sectors, in traditional and mass production industries, as well as in services, internal R&D activities may be negligible, but nevertheless, strong innovation efforts may be undertaken. Again, the composition of the innovative activities carried out in firms and industries can shed new light on the strategy and the objectives that are pursued.

Summing up these alternative firm behaviours and industry patterns, we can argue that a strategy focusing on product innovation follows from a search for *technological competitiveness*, based on high productivity rooted in quality advantages and the control of new and dynamic markets. This is typical of firms at the technological frontier, leaders in their market segments or entering new fields of activity.

A focus on process innovations follows from a strategy of *active price competitiveness* in established markets with productivity growth rooted in innovation-based restructurings. This is typical of mature markets with more intense competition, and of firms adopting a "follower" strategy.

Non-innovators, on the other hand, may survive essentially with cost savings in what can be termed a *passive price competitiveness* strategy. Due to the industry-specificity of technological opportunities and market conditions, it is possible to identify the industries that tend to be dominated by one of these firms' behaviours. Moreover, industries in different countries are subject to a competitive pressure in increasingly global markets similar to the one that firms have to face in a given market. However, the analogy between firm and industry-level processes stops here, and a fundamental difference is found when the innovation-employment relation is investigated.

Empirical studies have shown that most innovative firms have better performances than non-innovative ones in terms of output and employment, regardless of industry, size or other characteristics. This does not clarify, however, whether such performances are obtained expanding markets and employment or simply by stiffening competition with other firms and taking business and jobs from them. The only way to assess this is to look at the sectoral patterns; the evolution of sectoral value added and employment may show whether the gains of innovative firms have been greater or smaller than the losses of non innovative ones.

Demand comes back into the picture here. While an individual firm faces a large potential demand, and its performance essentially depends on its competitive success, an industry faces a real demand constraint, even when a strong export orientation exists. When demand grows rapidly a variety of firms' strategies are possible, the competitive pressure is reduced and it is more likely that a net positive employment outcome may emerge from the processes of innovation and competition among firms.

Conversely, in a context of weak demand, net job losses are much more likely to emerge, as competition gets stronger and firms' innovative strategies are mainly

targeted at expanding market shares - via cost cutting, process innovation, etc. - at the expense of domestic competitors and, in particular, of non innovative firms.

Technologically competitive firms (and industries in particular countries) concentrating on product innovations tend to expand (or preserve) their market shares regardless of the dynamics of demand. Firms (and industries) relying mainly on cost-reducing process innovations may expand production only in growing markets, while in conditions of stagnant demand they are likely to lose out to competitors with new, higher quality products. Similarly, non-innovators are likely to survive only in markets with sustained demand and little competition, and to disappear when demand declines and price and non-price competition increases.

This complex combination of innovative strategies, competitive conditions and demand patterns has to be understood in order to investigate the employment outcomes. This is best done by shifting the analysis to the industry level, so that the evolution of supply can be linked to that of demand within the existing market structures.

A further consideration is needed on demand conditions. A vast literature has examined the association between changes in technological paradigms and long cycles of economic growth; between the introduction of innovations and business cycles; between demand-pull factors and the shaping of new technologies. While the role of demand can be clearly pointed out in the study of the emergence of particular innovations, it is more difficult to disentangle the interaction of demand and supply factors when the impact of innovation is examined across all industries in shorter periods of growth.

The structure of demand, price elasticities and income elasticities are important for industry-specific employment trends. The higher the rate of demand growth in an industry, the higher employment growth will be. However, the positive demand effects may be compensated or even overcompensated by productivity growth. Indeed, there is empirical evidence that the positive correlation between industry-specific productivity growth and employment has turned into a negative one in more recent years (Appelbaum and Schettkat, 1995). Demand growth therefore does not necessarily lead to employment growth, as changes in technologies, organizations, skill composition and business structure may extract higher productivity from the same amount of labour.

A summary of the approach to the analysis

Combining the evidence of the impact of technological change and that of globalisation was one of the major challenges of the AITEG project.

From the analysis of the characteristics and nature of the parallel processes of technological change and globalisation specific models of innovation and internationalisation of production are identified. Using these models, the effects of globalisation and technological change on firms, industries, regions and the whole economy can then be determined. A major effort was devoted to the integration of the analysis of the two parallel processes. Firstly, the link between the strategy of firms in

innovation and globalisation was analysed in the context of the specific National System of Innovation and the broader system of production where firms are located. Secondly, the impact was assessed identifying the “top firms”, the key players of innovation and globalisation, and the rest of the industry (or the local system), which could be out-competed by the more dynamic firms. Thirdly, the net impact, including indirect effects (through demand, inter-firm, inter-industry links), was considered in order to make a final overall assessment of the ability of technological change and globalisation of production to create more growth and employment.

The following sections of this report will provide more detail of the research of the AITEG project as they specifically relate and contribute to the issues mentioned above. Here a brief synopsis of the relevant research is outlined:

Nascia and Perani review the statistical sources and build on the New Cronos database, which reports time series of aggregate national and sectoral data. In terms of sectoral data, they also draw on the OECD Stan database and Eurostat Structural Business data. The Cronos database also includes CIS data on innovation, total R&D personnel in the business enterprise sector in full-time equivalent, total R&D personnel in the government sector in full-time equivalent, and other data sources relevant to innovation and globalisation.

Ietto-Gillies argues that MNCs strategies may lead to a pattern of industrial location not fully congruent with the one emerging from the new trade and location theories. In other words, the new trade theories fail to take into account firm strategies, which greatly determine the impact of globalisation. Most importantly, the MNCs’ ability to plan and organize across different national regulatory regimes may give them special advantages linked to distributional issues and strategies. The importance of these regulatory regimes has been missed by the new trade theories, and Ietto-Gillies’ contribution is pivotal for AITEG’s research on globalisation.

Balcet and Enrietti identify four firm strategies: multi-domestic strategies, regional strategies, multi-regional strategies and trans-regional, or global strategies. They evaluate the impact, both quantitative and qualitative, of globalisation on employment in home and host countries through the analysis of the implied trade flows and intra-group trade flows in particular.

Castellani and Zanfei look at the impact of internationalization on globalizing companies’ performances, using firm-level data on the Italian manufacturing industry (home country perspective); second, they look at the impact of inward investments on the performances of European firms, as a measure of spillovers of globalisation on host economies. They draw on the Amadeus and D&B databases, the Argo database and the MCC database, for their econometric analysis.

Evangelista, Perani and Savona add specifically to innovation theory. They measure the direct impact of different types of service firms’ innovation strategies on employment through the creation of new services, the quality of pre-existing services, the introduction of new processes and delivery systems. This analysis of the employment impacts of innovation in services is a much-needed contribution.

Following from Ietto-Gillies' insight into the importance of spatially-specific resources, **Cantwell and Iammarino** add simultaneously to globalisation and innovation theories and evidence. They examine how particular corporate trajectories of MNCs have interacted with spatially-specific resources for the creation of new competencies in some of the leading regions in the EU. They find that there is a risk of regarding innovation as independent of locational context, which most of the existing literature has done. In terms of data, in stage one, they examine patterns of technology and production specialisation in each region, and in stage two, they carry out research at the firm level. The paper is a dual contribution: a joint theoretical treatment of globalisation and innovation, and an empirical contribution to the latter.

There is also have a dual contribution to globalisation and innovation theories in the research of **Narula and Criscuolo**. They concentrate on the global generation of technology by MNEs and look both at the innovative activities of foreign firms that operate in the European Union and the innovative activities of European firms that operate outside the EU. They differentiate between "home-base exploiting" R&D (where technological knowledge tends to flow from the parent firm's laboratory to the foreign-based facility so that the technological advantage of the affiliate primarily reflects those of the home country) and "home-base augmenting" R&D (where new knowledge is absorbed from the local scientific community). They show that the lower share of home-based augmenting R&D can be explained by the fact that asset-seeking R&D investments require the creation of both internal *and* external linkages. Narula & Criscuolo concentrate on the science-based sectors, while drawing mainly from the United States Department of Commerce, Bureau of Economic Analysis database of United States direct investment abroad and foreign direct investment in the United States. They also draw from benchmark survey data on R&D spending classified using the Standard Industrial Classification at three-digit level disaggregated for France, Germany, the Netherlands, Switzerland and the United Kingdom starting from the 1992 surveys. Lastly, they make use of the OECD Activities of Foreign Affiliates database, as well as the BERD and STAN databases.

Two contributions to the project try to integrate the innovation/ globalisation/ growth/ employment complex. First, apart from the obvious country-level $(X+M)/GDP$ (export plus import over gross domestic product) measure of openness, **Gambardella, Mariani and Torrisi** use two proxies of openness at the regional level. These are the quantity of goods transported to and from regions to any other European regions; and the difference between patents to companies in regions and to individuals in regions. They also distinguish between outward-looking activities in regions (goods transported from regions, regions with a high number of patent assignees) and inward-looking ones. They suggest the use of two databases: the Eurostat Regio database (1999) and the patent database compiled by Eurostat with patents applied for at the European patent office, classified by regions. From the latter, they derive an equation with the number of people employed by Nuts2 region as the dependent variable, and with independent variables including wages and salaries, and characteristics of regions such as the technological intensity of the region (e.g. patents), and measures of the degree of internationalisation of the region. Based upon this regression, they determine if regions with a higher number of employees are also regions with higher technological intensity and a higher degree of openness. Subsequently, they use a three-dimensional panel for their estimation, which includes sectors along with regions and time. As an extension to this research, they intend in future work to develop a

more sophisticated model with a two equation system involving employees and wages as dependent variables. This kind of model gives us a measure of the strength of the relationship between innovation, openness and employment, at the regional level, and at the sectoral and regional level gives us a measure of the strength of the relationship between innovation, openness and wages. This work thus creates an integrated framework for globalisation, innovation, and employment.

The contribution from **Molero and Lopez** investigates to what extent basic technological conditions that constitute a technological regime explain the process of the international expansion of economies. They also relate different patterns in terms of the latter with growth and employment, with a view to identify mechanisms and guide innovation policy in various contexts. Their basic sources are firstly, the CIS, which allows them to study the technological behaviour of innovative firms comparing different groups of them according to their share of innovation capital; second, a survey, the CDTI, which covers a large number of firms from 1984 to 1995; third, they look at two sectors through a questionnaire; and last, they adopt a macro approach based upon a sectoral database created for the last five years drawing from the OECD Stan and MSTI databases, the new Cronos database, the US patent office, the sectoral CIS and Economic Commission for Latin America (ECLA) data. Their main aim is to make dynamic comparisons across countries over time in terms of the way in which innovation, internationalisation and productive structure interact.

More detailed evidence on the specific research of the project is provided in the following sections.

3.2 The impact of technological change

3.2.1 Patterns and impact of technological change in European industry: evidence from the European Innovation Surveys

Moving from a set of common starting points – broadly outlined above – four works investigate the key research issues summarised below, using a variety of methodologies and levels of analysis.

The research address all the levels of analysis required in this field. The first three papers cover the whole of European manufacturing industries, using a sectoral breakdown for a large number of countries. They provide background on the diversity of innovation patterns in Europe (Nascia and Perani) and on the employment impact of specific strategies, namely product or process innovation (Antonucci and Pianta). The last paper moves ‘down’ to the firm level in order to study the link between technology and international production (Castellani).

The article by Nascia and Perani [40] addresses the complexity of innovative activities and the diversity of the strategies associated with them. Firms introduce innovations that differ regarding their typology (product, process); the sources used (internal, external); the inputs employed (R&D, design, investment, and so on); and the objectives pursued (reduce costs, enlarge markets, and so on).

The authors provide a useful overview of the results of the CIS 2, providing basic information on the characteristics of innovation in manufacturing industries in all European countries. These are clustered in three major classes: the industries dominated by product innovators focusing on markets, the group of process innovators focusing on costs, and sectors emerging as ‘general innovators’ which combine both strategies in order to advance on all aspects. Within European industries, some innovation dimensions appear to be the result of specificities of national innovation systems, while others are common features of sectors across all countries, as shown by an analysis of variance. Finally, regarding the economic impact of innovation - as described by the share of sales of the industry due to product innovations – the total expenditure for innovation, the R&D component, and the cooperation with universities are all found to be important factors.

The article by Antonucci and Pianta [22] addresses the controversial issue of the impact of new technologies on jobs. They use CIS 2 data at the sectoral level, associated with economic and employment variables and cover manufacturing industries in eight European countries. The authors develop a model where employment is affected by demand dynamics, labour costs and innovation variables associated with strategies of technological or price competitiveness. The empirical findings show that European industries, in the context of the modest aggregate growth of the 1990s, were dominated by the latter strategy, associated with process innovations, leading often to generally negative effects on jobs.

The paper by Castellani [28] explores the link between foreign investment and the technological trajectories of multinational corporations. A large body of literature has argued that the presence of foreign subsidiaries is expected to strengthen the productivity of multinational firms also in their home base. Using a large sample of Italian manufacturing firms, total factor productivity in the 1990s is found to be positively associated with the creation of foreign affiliates, especially when these are located in advanced economies such as the US.

3.2.2 National studies on innovation in industry and services

The availability of detailed innovation survey data in the UK, Italy, Sweden and Spain has opened the door for deeper analysis of the patterns, dynamics, and effects of the specific forms of technological change at the firm level. By pointing the key elements shaping the direction of technological change and the factors associated with economic performance this analysis opens up the ‘black box’ of innovation.

The research by Cox, Prevezer and Frenz [2] develops patterns of UK innovation activities. This paper examines how the OECD classification of industries into high, medium-high, medium-low and low technology industries calculated for the whole of the OECD countries shape up in comparison to the UK CIS2 results. Some features of the UK rankings are highlighted and anomalies between the two datasets pointed out. For instance the CIS data gives a lower R&D intensity for the UK aircraft and motor vehicle industry than does the OECD. Overall however they conclude that the OECD classification of the whole group of countries into the four categories of R&D intensity is a good starting point to analyse patterns of innovation. The second part of this paper contrasts patterns of innovation activities in the high technology industries

with those in low technology industries for the UK. The main conclusions from this examination of innovation patterns are the following. The relation between product innovation and high technology industries is confirmed - that there is a strong relationship and high technology industries do tend to do more product innovation than lower technology industries. This does relate to higher research intensity, so it appears that higher R&D expenditures do lead to greater product innovation. Process innovation is not such an obvious case, with no clear division between high and low technology industries in their capacity and tendency to do process innovation.

In another paper on innovation Cox and Frenz [3] examine the relationship between business performance, R&D expenditures and innovation output. The authors matched CIS2 with performance data as derived from the FAME database and find that many enterprises who claim to have produced innovation output, did not register any expenditures on formal R&D. Moreover, they find evidence that it is innovation output, the introduction of new or improved products and processes, which is correlated to productivity growth, not a high expenditure on R&D. The UK's policy to support innovation via subsidising R&D expenditure may on the one hand fail to effectively target many firms who are successful innovators and on the other reward firms that engage in levels of R&D spending beyond the point where marginal social cost equals marginal social benefit. The evidence strongly suggests that the key to supporting productivity growth in the economy as a whole is to develop policy initiatives that are able to facilitate product innovation directly.

The research by López and Zlatanova [16] uses the Spanish CIS to perform a case study of the innovative firms of network components. The sector of telecommunication firms in Spain devoted to networks of software and hardware manufacturing is characterised by having its demand very dependent on the principal operator – Telefonica. The paper is about the role that Telefonica plays in the design of the research and innovation plans of the firms. The preliminary conclusions are, first, that the innovative activity of Spanish firms of the sector in recent years cannot be understood without linking it to the internationalisation of their activities and, second, this internationalisation had also been developed jointly with the internationalisation dominated by Telefonica.

López and Pueyo [17] further researched the role that Telefonica (the main PTOs - Plain Old Telephone Services - in Spain) has played in the technological and enterprise development of the country. The initial section (section 2) takes care of the early formation of the data transmission networks during the 1970s. In this period, Telefonica created an industrial group with its own companies and foreign technological partners (Fujitsu and AT&T). The significant technological achievement was the RETD (Special Network of Data Transmission). The RETD was one of the first of its type in the world. Finally this network was surpassed by the expansion of Internet. A complete description of this process and the failures of the RETD are presented. The second part (section 3) is a study on the recent divestiture of Telefonica and how it has influenced the evolution of the telecommunication equipment suppliers.

Sellenthin and Hommen [21], and Nählinder and Hommen [20] provide further study of innovation in the industrial sector. Using the Swedish CIS II, they conduct empirical analyses of innovative strategy at the industrial level. The aim of the

studies is to point out specific forms of innovation, and international investment leading to particular models of technological change and internationalisation, which have different employment effects. This allows the authors to identify the driving forces of innovation and internationalization of production in specific national industries, the interaction with industrial structures and local production systems, and the strategies pursued by large firms and other key actors.

The first of the studies (Sellenthin and Hommen) deals with innovation in Swedish manufacturing and focuses on the identification of different strategies of technological innovation, relating these to established typologies and theories of innovation strategy by means of a factor and cluster analysis. The study by Nählinder and Hommen deals with the innovative capacity of part of the Swedish service sector, namely (technology based) Knowledge Intensive Business Services (KIBS). This study uses regression analysis to examine the relationship between the demand for skilled labour in KIBS and the innovative capacity of firms in this sector. It finds that R&D activity is a 'driver' of firm-based training and investments in human capital within this part of the service sector. The policy implication of both studies is the need to target industries with high rates of product innovation.

Technology and innovation are increasingly recognized as major forces behind the structural change towards service economies, with information and communication technologies playing a pivotal role in the process. Despite this, there are only a limited amount of studies exploring the nature, extent and economic impact of technological change in services. The paper by Evangelista and Savona [36], using Italian data, introduces a much needed extension to the case of service industries addressing - in parallel to the paper by Antonucci and Pianta - the issue of the employment effects, highlighting similarities and differences with manufacturing in terms of innovation and its impact on jobs.

Evangelista and Savona [36] also address the controversial issue of the impact of new technologies on jobs, using CIS 2 data but covering service industries in Italy only. The authors aim at exploring on solid empirical grounds, the varied nature of innovation activities in services, the impact of innovation on economic growth and employment at the level of individual firms, in the different service industries and in the service sector as a whole.

They show that services are highly heterogeneous in terms of their basic economic features, their knowledge content and consequently their growth potential. Highly diverse also is the impact of technological change, and ICTs in particular, on employment and growth in services, according to the types of firms' strategies and across industries. In this regard a crucial distinction has to be pointed out, between sectors producing and disseminating new ICT based services and sectors merely adopting ICTs to cut down costs and rationalise the production and distributive structures. As far as the relationship between innovation and employment, different technological regimes have a diverse impact, both on the employment growth and on the skill structure of the different service sectors. Innovation activities tend to substitute low skilled jobs with highly qualified jobs. Among small firms and in less than a half of the service sectors considered in our analysis the net effect is positive, particularly in industries with a strong scientific and technological base. Among the most traditional and least innovative sectors such net impact is negative. This evidence

confirms that simplified generalisations regarding the so-called service-based society and the over-optimistic scenarios associated with the growth of services as such are therefore misleading.

As far as policy implications are concerned a progressive shift of focus is needed away from manufacturing alone, towards the manufacturing and services sectors taken together, with an explicit consideration of the links and synergies between the two sectors. This shift in the policy agenda also has to take into account the model of specialisation of national economies within services. Actions devoted to strengthening the most dynamic and knowledge intensive services and, in general, a major focus on “selective” rather than “generic” or “horizontal” actions must represent a priority in the policy agenda. Further, upgrading the competencies and the levels of qualification of the work-force might be a necessary but not sufficient condition to avoid technological unemployment. The case of Italy has shown that the net effect of the substitution process between qualified and unqualified labour might be negative. Compensation mechanisms are likely to be effective only in the case of sustained growth rates of demand. This in turn opens up the possibility of links between structural and industrial actions on the one hand and macro-economic policy on the other.

3.3 The impact of globalization of production

The contributions made by several authors within the AITEG research project on the issues related to international production and its effects on economic performances are reported below.

This research on globalisation falls into three main areas. The first focuses on the role played by multinational enterprises in the evolution of host economies. The second one refers to the process through which internationalisation generates new knowledge and competitive advantages. The third area reviews contributions on the interactions between regions (and other sub-national units) and internationalisation processes.

3.3.1 The impact of international investment and inter-firm agreements

The changing role of multinational enterprises in host economies

Ietto-Gillies [7] produced one paper and a book chapter [8]. In her work she developed two complementary methods of assessing the degree of internationalisation by introducing two related indices, the internationalisation index (Ii) and the Network Spread index (NSi). Ii is calculated as the ratio of foreign to total companies' affiliates and is designed to capture the degree of foreign projection of the company. NSi aims to capture the degree of geographical (by nation-state) extensivity of the MNC. It is the number of foreign countries in which the company has affiliates in relation to the total number of foreign countries in which it could potentially have operated. The latter is identified as the number of countries in receipt of inward FDI. She gives empirical estimates for the two indices and for the largest EU transnational companies (TNCs) and analysed the possible impact on countries and sectors and draws relevant policy

implications. The assessment is based on the international location of the TNCs' affiliates or subsidiaries. Ietto-Gillies shows that there has been a quantitative and qualitative leap in the internationalisation process from the 1970s onwards by doing empirical work on a 35 year period for the UK. The degree of foreign projection, that is the propensity of the largest UK manufacturing companies to locate their affiliates abroad, has been increasing steadily. This is shown by changes in the value of the Internationalisation index (Ii). The propensity to spread the activities across many foreign nation-states is assessed by the number of host countries in which the companies operate. The results show that the average number of host countries in which our TNCs have located affiliates more than doubles in the 35 year period, moving from 15 in 1963 to 40 in 1997. In the post-1970 decades there appear to be an overall size effect; companies operate with wider networks of affiliates both at home and abroad and operate in a considerable larger number of host countries.

The work on NSi has also led to a contribution by Grazia Ietto-Gillies and Marion Frenz [5] to the United Nation's Conference on Trade and Development in the World Investment Report, 2001.

Using comparable firm level data at the 3-digit sectoral (SIC) detail, obtained from the combination of Dun and Bradstreet's *Who Owns Whom* and of Bureau Van Dijk's Amadeus, Castellani and Zanfei [32] describe the sectoral patterns of manufacturing foreign direct investments in France, Italy and Spain, and relate these patterns to the labour productivity of domestic enterprises in the same countries over the 1993-1997 period. Their results depict a rather comprehensive, albeit essential, picture of multinational presence and of its effects, with reference to the population of firms with 50 employees or more. While the absolute size of foreign activities (as measured by employment in foreign owned firms) is the highest in France, the ratio of foreign presence relative to total employment is the highest for Spain (over 50% of total employment is in foreign owned firms). Italy is characterised by the lowest multinational presence. Sectoral patterns reflect the characteristics of these countries' economies, although the exclusion of firms with less than 50 employees somewhat biases the general picture, especially for Italy and Spain. In Italy the share of total employment represented by foreign activities is particularly high in some traditional sectors, like food and beverages; but it is also high in some high technology sectors like chemicals and pharmaceuticals; in Spain, foreign presence concentrates in such industries as rubber and plastics and non electrical machinery, although it is on average high in several other industries; in France foreign presence appears to be rather evenly distributed across industries, with less remarkable exceptions. Looking at the productivity of firms, France appears to have the highest levels for both domestic and foreign enterprises, Spain the lowest levels for both, and Italy is located somewhere in between.

Castellani and Zanfei [33, 34] examine the causal effects of foreign presence on domestic firms' productivity. They make an important methodological point that helps us understand why most recent studies find no evidence of such an effect. They describe how a specification error might be responsible for biasing the result of existing studies, increasing the likelihood of these finding no productivity spillovers (Castellani and Zanfei [33]). The argument is that the existing literature implicitly assumes that an increase in within-sector activities of foreign owned firms and in overall sectoral activity in the same proportion should cause no effect on domestic firms' productivity. In other words, externalities from aggregate and from foreign

activities are expected to be of the same magnitude. Using data for Italian firms, they find that this condition is not satisfied. Furthermore, positive spillovers show up when they allow for a general specification.

In a different paper Castellani and Zanfei [34] explore the role of country and firm level specificities. Exploiting the comparability of the data (obtained from the intersection of *Who Owns Whom* and Amadeus as recalled earlier) they run regressions on a sample of 3,932 firms (of which 1,950 are located in France, 980 are located in Italy and 1,002 are located in Spain), and confirm evidence of positive and significant effects of inward investments on domestic productivity in the case of Italy, while the impact is non significant or negative in the case of France and Spain. It would then appear that the balance between positive spillover effects, as determined by technology transfer and demonstration effects (Mansfield and Romeo, 1980, Dunning, 1993), human capital mobility (Fosfuri *et al.*, 2001), and linkage creation (Rodriguez-Clare, 1996) on the one hand, and negative effects, stemming from the crowding out of local firms (Aitken and Harrison, 1999) on the other hand, is markedly different across the 3 examined countries. Structural characteristics of the examined countries might help explain these differences in spillover effects. Among other factors, Castellani and Zanfei [34] find that that technology gaps between host and home countries (as measured by differences in productivity levels of foreign and domestic firms) positively affect domestic productivity, while absorptive capacity, measured by local firms' productivity levels, does not leverage productivity spillovers from FDI. This would confirm a "catching up" hypothesis (Findlay, 1978), which identifies a positive relation between the size of technological gaps and growth opportunities induced by foreign investments, and would contradict a "technological accumulation" (Cantwell, 1989, Kokko 1994) hypothesis, which stresses the role of domestic absorptive capacity and of coherence between foreign and domestic technology as determinants of virtuous effects of inward investments. The fact that our measure of absorptive capacity does not increase the likelihood of productivity spillovers may have to do with the characteristics of recipient countries. Different from LDCs, advanced countries are relatively close to the technological frontier and might have reached a threshold level of absorptive capacity required to benefit from foreign investments, so that at the margin further increasing local firms' accumulation of technology would not augment the productivity spillovers of foreign investments. One should also mention that cross-sectoral differences also matter. In fact, the role of absorptive capacity in the generation of productivity spillovers appears to be positive, although barely significant, in the case of science based industries. Even though we should interpret this result rather cautiously, it may signal that domestic firms endowed with high technical skills are better off taking advantage from complex and rapidly evolving technologies which are being handled by TNCs in these industries.

International production as an asset seeking process

Castellani [29] produces rather robust econometric evidence on the overall effect of Italy's FDIs on internationalising firms' technological trajectories. His idea, which is by and large consistent with the framework outlined by Criscuola and Narula [47], is that by setting up subsidiaries in foreign countries, multinationals can learn foreign technologies, grasp new uses and applications for their own products and technologies, adapt products and processes to specific needs, and improve their organisational processes as well as their distribution strategies. This should determine an upsurge in

technological trajectories that will eventually translate into higher productivity levels for internationalising firms as opposed to non internationalising ones. Using the already mentioned intersection of Amadeus and *Who Owns Whom* as a database, he estimates a dynamic equation for firms' total factor productivity as a function of the investing status, controlling for fixed effects and endogeneity. His results support the view that the creation of manufacturing subsidiaries has a positive impact on firms' productivity trajectories; furthermore, this positive impact is greater when subsidiaries are created in regions where knowledge spillovers can be expected to be higher, such as the US.

In a companion paper Barba Navaretti, Castellani and Zanfei [27] compare the results referring to Italy with those obtained for France and Spain, and provide some sectoral details. This extension of the analysis highlights the fact that outward investments have a particularly positive effect in high technology sectors. A key implication is that countries concentrating their investments in other industries, as in the case of Italy, might generate much lower long-term advantages for internationalising firms.

3.3.2 National studies on internationalization in industries

Balcet and Enrietti [26], adopting a firm-level case study approach, offer a more detailed analysis of multinational strategies and of their economic performances. They focus on FIAT as a relevant case of multinational expansion in the Automotive industry, and illustrate its evolution over time from what they depict as a multi-domestic strategy, characterised by subsidiaries serving local national markets as an alternative to exports and licensing, to a regional and global orientation, wherein an intra-group division of labour can be envisaged within and across macro-regions.

A turning point in the transition towards regional strategies occurred in the late 1980s when FIAT started technologically advanced assembly lines in Poland and concentrated there the production of a new car – the new Cinquecento – for the whole European market. Furthermore the decision was taken to set up a new production complex in Argentina, in 1995, which paved the way to the development of a network of specialised foreign affiliates in the Mercosur regional area. Based on these regional networks, centred in Latin America and Eastern Europe, FIAT then developed what Balcet and Enrietti call a focussed global strategy.

As the authors argue, the technological and organisational side of globalisation in the examined industry can either be identified with the “world car” strategy or the “common platform” strategy. The former one consists in the attempt to design a car that can be manufactured and/or sold in different markets, as in the case of FIAT Palio or of the Ford Focus. The common platform strategy consists of increasing the number of common parts between cars of a different type, thus enabling a more intensive exploitation of economies of scale and scope in the production and design phases.

The FIAT case is characterised by a combination of both world car and common platform strategies. The innovative idea was to produce a world car oriented to the needs of emerging countries, in Eastern Europe, Latin America, Africa and Asia, using a platform that is common to a whole family of models developed for Italy and the European market. This strategy implied the organisation of a flexible and adaptive

network of global sourcing, supported by an information and communication system centralised in the home country; and the creation of a global engineering network integrating the R&D units located in Italy, Brazil and Turkey, and supporting the adaptation and development of products for the different markets.

The authors are then able to assess the impact of this globalisation strategy in terms of trade flows, of changing firm boundaries and vertical supply relationships, and of employment. As far as trade flows are concerned, their detailed analysis of Istat 8 digit data on foreign trade, and of intra-firm trade data supplied by FIAT itself, highlights a three stage process: first, a strong export flow of parts, components and machinery from Italy to foreign affiliates; second, a decline of component exports from Italy due to growing local content of foreign productions; third, growing imports of components by Italy as foreign units develop.

The impact of FIAT's globalisation on vertical relationships is also striking. In a scenario that is characterised by growing outsourcing processes, higher modularisation of parts and components, and increasing involvement of manufacturers in complementary service activities, supplier relationships are undergoing a deep change as a result of globalisation.

Focusing on FIAT's activities in Poland and in Turkey, the authors find that: (a) FIAT has actively encouraged a "follow the client" type of international involvement of suppliers; (b) Italian car suppliers were also forced to restructure their plants and introduce new work organisation, hence stimulating them to increase their productivity levels; (c) local content has grown as a result of the recourse to local suppliers, which underwent a rigorous process of selection (lowering their number over time) and re-organisation (increasing their efficiency); (d) while R&D is still concentrated in Italy, technology transfer and adaptation to local conditions are assured through technical assistance, training and technical missions involving local and foreign based suppliers.

Finally, the direct effect of globalisation on employment can be estimated for Poland, and turns out to be negative as a whole as far as total employees of the local subsidiary of the Italian company are concerned, due to the de-verticalisation process which occurred at FIAT in the early 1990s (employment dropped from 24,427 to 11,532 in 1991-1996 at FSM-FIAT in Poland). One should note however that most of these changes in employment levels are actually the mere results of a different definition of firm borders: workers continued their activity in factories which have simply changed ownership over time.

The regional dimension of international production

As anticipated earlier, the effects of internationalisation can be better understood if sub-national sets, such as regions and industrial districts as relevant geographical areas are used as units of analysis. Several of the papers produced within the AITEG project adopt this analytical point of view.

Gambardella, Mariani and Torrisi [39] estimate the determinants of labour productivity in European regions during 1989-1996 by comparing three potential explanations of regional advantages: technological capabilities, agglomeration economies, and openness. The novel aspect of this work is twofold. First, unlike previous studies

which have focussed on explanations of regional advantages that are internal to the localities – e.g. local infrastructures or institutions, localised spillovers, local networks (Jaffe, Trajtenberg, and Henderson, 1993) – this paper argues that there is another relevant factor that affects labour productivity. This is the “openness” of the regions, and in particular their international openness. The meaning of openness, its determinants, and the mechanisms by which it affects output per worker are discussed in the paper. Second, to study the effect of openness a new measure is used: the number of airplane passengers embarked and disembarked in the region. The authors found that in spite of some limitations, this is a meaningful index for the openness of the regions.

The authors derive a labour productivity equation from a standard new trade theory model (see Redding and Venables, 2001; Overman, Redding and Venables, 2001; Midelfart-Knarvik, Overman and Venables, 2001), which they extend to take into account agglomeration economies and other factors. An unbalanced sample of 622 NUTS European regions during 1989-1996 were used, with data obtained from the Eurostat database REGIO constructing fairly homogeneous regions for Italy, Spain, France, Germany, Belgium, the Netherlands, Sweden, Portugal and the UK. Their econometric regressions (which include instrumental variables to account for endogeneity problems) confirm existing results in the literature that employment density and patents affect labour productivity. In fact, agglomeration economies have been a typical explanation of regional advantages.

Several authors have emphasised the importance of local infrastructures and the local milieu for innovation and growth (e.g. Saxenian, 1994; Porter, 1998; Swann, Prevetzer and Stout, 1998). Another typical explanation of regional advantages is technology. Audretsch and Feldman (1996) showed that in the US, technological activities tend to cluster. Verspagen (1997), Caniels (1999), and Breschi (1999) obtained similar results for Europe. A common feature of these studies is that they look for explanations of regional advantages that are internal to the localities - e.g. local infrastructures or institutions; localised spillovers; local networks.

Focussing on international delocalisation in the “Made in Italy” sector, Schiattarella and Rossetti [45] also emphasises the role of regional and sub-regional systems of firms in the generation and exploitation of competitive advantages. Examined sectors are: textiles and apparel, and leather and shoes. These sectors are characterised by a strong presence of small and very small firms located in regional networking systems (the Italian industrial districts) that delocalise production in foreign regions.

This research uses 1990-97 ISTAT data disaggregated at the level of regions, provinces, goods and destination countries to identify the flows of goods between different geographical areas along the two lines of production (i.e. textile and apparel, and leather and shoes). Eurostat REGIO (2000) are also used to obtain information on other regional characteristics such as technological, economic, demographic, infrastructural, social characteristics and living conditions. Finally, the results of a recent survey in the Veneto region are utilised to allow for some controls on the size, age and technology used by individual firms. Compared to regions with low or no delocalisation of production, regions that highly delocalise production abroad show a lower ratio of low-skilled workers and an increase in the number of high-skilled

workers. The same applies for wage differentials between low and high-skilled workers in areas with different level of delocalisation of production.

These results seem to suggest that when regions operate a finer geographical and organisational division of labour in production activities, they can redesign their activities in such a way to keep control on the final markets and to use a more qualified labour force. This is characterised by higher productivity and higher wages.

Archibugi and Coco [23] by analysing the globalisation of technology in the three forms of international exploitation, global generation (by MNEs) and technology collaboration in the industrial and academic world, try to draw some conclusion about the European gap in the learning economy to inform policy actions.

Clear few signals do emerge from the collected data: First, Europe is not at the core of the globalising learning economy, lagging the United States and Japan on key dimensions of knowledge production as well as in high-tech sectors. Second, in spite of the good mixture of competitive and cooperative incentives, the European Commission's policies have not managed to generate a European Union for business R&D. Given that the budget of the European Commission for Research and Technological Development is less than 6% of the total European expenditure, this result is hardly surprising.

Many European firms have a preference to locate substantial R&D and innovative activities in the United States rather than in other European countries. Likewise, they have become keener to sign strategic technological alliances with United States' counterparts than with European ones, probably because of the attractiveness of the size, quality and direction of research carried out on the other side of the Atlantic. Another possible explanation is that US based companies are less likely to be direct market competitors for European companies. However, the European academic community has a stronger and increasing propensity towards intra-European collaborations, while US-European academic collaborations are decreasing. This aspect deserves to be further investigated.

Given this evidence, the authors advocate a stronger coordination at the European institutional level in order that the management of knowledge receives the same attention and authority as the management of money.

3.4 The globalization of technology

Research in this area focuses on the interaction between globalization and technology. This research takes the form of analyses of indicators of globalization of technology, taking into consideration the global exploitation and generation of innovations, and global collaborations. Additionally, more detailed analysis investigates the impact of technological activities of MNCs, specifically the effects of inter-firm international technology transfers and regional dynamics of innovation and production.

3.4.1 The impact of different forms of globalization of technology

The paper by Criscuola and Narula [47] starts from the premise that multinational companies (MNEs) play a dominant role in the innovation activities of their home country and control a vast proportion of the world's stock of advanced technologies. Their decisions in term of mode, location and exploitation of their R&D results greatly influence the home country's technological potential and competitiveness (Patel and Pavitt, 1999). The growing significance of the internationalisation of R&D activities of MNEs over the past two decades has therefore been cause of some concerns among innovation policy makers. In Europe it has been advanced that the performance of R&D activities in foreign countries might result in a "hollowing out" of domestic capabilities, whenever national firms locate innovation activities in fast growing fields abroad. This is regarded as indicative of a weakening of the national innovation system and an erosion of technological competitiveness (ETAN, 1998). In the United States the internationalisation of industrial R&D has brought with it worries about a possible impoverishment of the national technology base due to the increasing local R&D activities of foreign MNEs. If it is important to understand the motives behind the MNEs' R&D location decisions, it is also crucial to assess whether the decentralisation of R&D activity entails only an outflow of knowledge. Foreign affiliates can represent an inflow of technological knowledge to the home country whenever their activity is explicitly aimed at generating new technical knowledge and gaining access to localised sources of innovation.

This process of 'reverse technology transfer', as defined by Mansfield (1984), is not new: but it has mainly been examined as a means to improve the MNEs portfolio of knowledge and technological assets (i.e., *intra-firm* reverse technology transfer) (Frost, 1998, Branstetter, 2000, Gupta and Govindarajan, 2000, Håkanson and Nobel, 2000, 2001) and the firm's productivity (Fors, 1997, Castellani, 2001, Braconier *et al.*, 2002). However, reverse technology transfer may also have significant effects on the home country, when knowledge and resources are transferred back to the parent firms and spill over to the home economy through its linkages to domestic firms – i.e., *inter-firm* reverse technology transfer.

The internationalisation of R&D has been driven by a myriad of factors, the most prevalent of which are the need to respond to different demand and market conditions across locations, and the need for the MNE to respond effectively to these by adapting their existing product and process technologies through foreign-located 'home-base exploiting' (HBE) (Kuemmerle, 1997) or 'asset-exploiting' (Dunning and Narula, 1995) R&D facilities. However, over the last decade supply factors have become an increasingly important motivation for carrying out R&D activities abroad (Kuemmerle, 1999, Serapio and Dalton, 1999, and Patel and Vega, 1999). With these 'home-base augmenting' (HBA) (Kuemmerle, 1997) or 'asset-seeking' (Dunning and Narula, 1995) R&D facilities MNEs aim at absorbing and acquiring technological spillovers, either from the local knowledge base (public infrastructure or to benefit from agglomerative effects in a specific sector), or from specific firms.

In connection to the internationalisation process of R&D activities it is possible to identify four principal cross-borders technological knowledge flows.

1. *From the parent company to foreign subsidiaries.* This flow of technical knowledge mainly takes place when MNEs establish HBE type R&D facilities.

2. *From host location to the foreign subsidiaries.* This flow of knowledge is connected to the HBA activities of foreign affiliates. The main objective of these facilities is to learn from local technological clusters (e.g. from the existence of a well-educated work-force, high-quality research institutions). This can be attained if they are able to establish both long-lasting interactions with external parties, notably customers, suppliers and competitors, i.e. if they become locally embedded.⁵
3. *From the foreign subsidiary to the parent (inter-firm reverse technology transfer).* The creation of a geographically dispersed network of R&D facilities not only relies on the capacity of foreign affiliates to acquire localized technical knowledge, but above all on the capacity of the multinational firm to ensure the diffusion of such knowledge within the firm. Although it is strategically important for the firm to ensure that knowledge diffuses within the company in order to exploit it across borders, knowledge transfer even within the firm is far from being an automatic process, especially when the flow of knowledge goes from the subsidiary to the home base of the firm. There are barriers connected to the characteristics of the technological knowledge to be transferred due to its complexity, context specific and tacit nature. But there are also motivational barriers, with the possibility that affiliates might be reluctant to transfer knowledge to other units of the MNE. In this case the organizational problem can be solved by establishing a compensation scheme to reward subsidiaries that contribute to the MNE knowledge base.
4. *From asset-seeking R&D facilities to other home country firms (intra-firm reverse technology transfer).* The extent of such knowledge transfer depends on a number of factors. First knowledge should flow within the MNE. Second, the successful diffusion of knowledge requires absorptive capacity in the receiver units (home country firms), which is “the firm’s ability to identify, assimilate, and exploit knowledge from the environment” (Cohen and Levinthal, 1989). Third on the occurrence of spillovers from the parent company to other home country firms. The existence of unintentional and intentional knowledge spillovers can mainly be attributed to the high degree of embeddedness of MNEs in their home country. It is in the home country, where the core productive and innovative activities are concentrated, that the linkages with external actors are strongest, but also historically defined.

⁵ As pointed out by Zanfei (2000) the decentralisation of R&D activities in foreign subsidiaries leads to a delicate trade-off between the autonomy of the subsidiaries and their integration into the rest of the multinational company. On the one hand, the MNE has to grant a certain degree of autonomy to foreign subsidiaries to allow them to become rooted in the local context. On the other hand, the MNE has to ensure a certain degree of integration, cooperation and communication among the different units of the firm to be able to assimilate and exploit the knowledge accumulated through R&D asset seeking investment.

Criscoula and Narula investigate the extent of such knowledge flows conducting patent citation analysis using a database on patenting activities of 116 European and US MNEs active in high-tech sectors (chemicals, pharmaceuticals, computers and electronics, and petroleum). The primary data source is the EPO database on patent applications from 1979-98.⁶

In order to investigate the main research questions, they applied a number of statistical tests on the patent citation data aggregated at the sectoral level. They identified the location of the invention by looking at the inventor's address. Only addresses in the European Union (EU) or the United States (US) were taken into account in the analysis. The region of ownership (also EU or US) is identified by the location of the headquarters of the multinational group. Then they know for each patent in which region the owner-company is located, and in which region the invention took place.⁷ They can therefore assume that the inventions occurred abroad reflect the R&D activities of foreign affiliates. They built a patent citation matrix where each column corresponds to the citing patent applicant (spillovers receiver) and each row contains the cited patent (spillovers generator).

Their findings indicate that HBA activities are now an important aspect of foreign-based R&D in the US and the EU. Firms from both regions tend to use their foreign-based R&D activities to tap into the knowledge base of the other (host) region, with the exception of the chemicals sector. European MNEs however seem not to be able to exploit the knowledge acquired abroad in their home countries, with the exception of the computers sector. Reverse technology transfer appears to be stronger for US MNEs.

In deriving policy implications based on the empirical analysis, several important caveats need to be stressed. First, while the results indicate that MNEs do engage in HBA R&D activity, the sample of firms only includes many of the world's largest MNEs. These firms are amongst the world's most successful firms, and they have considerable experience - as well as resources - to efficiently exploit cross-border knowledge flows. In addition, they have not taken into account R&D activity by other firms than MNEs in the sample in defining the knowledge base of a (host or domestic) region. Second, they have utilised a high level of industrial aggregation, and within that, on knowledge-intensive, mostly high technology sectors. Obviously, supply and demand imperatives vary considerably by sector and sub-sector. More mature technologies evolve much more slowly than nascent ones, and some tend to be less tacit than others. In other words, the importance of physical proximity to technology transfer varies quite considerably between technologies and products. Third, they

⁶ Patent citations represent a link to previous innovations or pre-existing knowledge upon which the inventor builds. When an inventor cites another patent, this indicates that the knowledge contained in the cited patent has been useful in the development of the citing patent. Patent citation can therefore be an indicator of knowledge spillovers, although with some limitations, mainly that it can only capture some of the technological knowledge transfer that is entailed in the process under analysis.

⁷ In case of multiple inventors, they use a fractional counting method, i.e., if there are p inventors in the EU and q inventors in the US, the EU is attributed $p/(p+q)$ of the patent, and the US $q/(p+q)$.

have seen considerable – and statistically significant – differences between the behaviour of US and EU firms. Data on internationalisation of R&D indicate considerable heterogeneity between countries of the EU (Archibugi and Iammarino 2000). For instance, Belgian and Dutch firms demonstrate a much higher level of R&D internationalisation than Italian or Norwegian MNEs. This reflects the fact that the various systems of innovation – and thus industrial and technological specialisations remain individual and distinct. A more holistic approach is needed, examining both exogenous (factor-endowments based aspects) and endogenous (government institutions and regulatory aspects) issues.

Although more empirical evidence is needed to fully appreciate the extent and determinants of the reverse technology transfer process, their findings seem to suggest that there is a potential positive effects for the home country's technological activity, and for its competitive performance in general from the re-allocation of MNEs' R&D activities abroad. Policy makers have tended so far to encourage domestic multinationals to maintain their R&D activity at home and have disapproved of the re-allocation of this investment to foreign countries. These concerns are founded on the hypothesis that R&D investment abroad is a substitute for R&D investment at home, and that outward FDI can lead to an erosion of the home country's technological advantages. Our analysis suggests that internationalisation of R&D by firms might accelerate the inflow of new technology from the countries at the technological frontier and it does not necessarily substitute R&D activities performed at home. Firms venture abroad and seek to internalise aspects of other countries' innovation systems. No country can possibly expect to provide world-class competences in all technological fields. Even the largest, most technologically advanced countries cannot provide strong innovation systems to all their industries, and world-class competences in all technological fields. The cross-border flow of ideas is something that has always been seen as fundamental to firms, and this imperative has increased with growing cross-border competition, international production, and with the need for acquiring multiple technological competences (Granstand *et al.*, 1997).

Some countries have regarded imported technologies as a sign of national weakness, and have sought to maintain and develop in-country competences, often regardless of the cost. The strategy of technological self-sufficiency is increasingly untenable in a globalising world. Relying on in-country competences may lead to a sub-optimal strategy, especially in this age of multi-technology products.

3.4.2 The impact of technological activities of MNCs

One of the crucial aspects of the ongoing globalisation of the world economy lies in the new modes of creating and diffusing new technological knowledge. The central role played by contemporary multinational corporations (MNCs) in such processes has been described in the evolutionary literature, stressing the metamorphosis of the MNC from mere “vehicle” of technical knowledge to “creator” of new technology. This has been seen as a key dynamic potential of modern MNCs, both for the evolution of the transnational firm as such and for the overall economic development of host locations. At the same time, the growing attention devoted by economic analysis to phenomena of spatial concentration has provided increasing evidence of the highly bounded character of technology creation and spillovers, highlighting the

implications for economic growth deriving from the beneficial interdependence between global creators of technology and regional and local innovation systems.

The evolutionary approach has shown that differences in technological growth and specialisation patterns are strictly dependent upon skills and capabilities, interactive learning, organisational modes and institutional settings, which are highly location-specific. That is to say, what happens inside the firm is fundamental, but the “cluster effect” indicates that the immediate socio-economic environment around the firm plays a critical role in determining a successful competitive performance. Besides, taking into account institutional diversity means to adopt a comparative “systemic” perspective: the interest in systems of innovation, and the recognition of their broad heterogeneity (even within national borders), has given rise to the problem of assessing the extent of technological and economic convergence across countries and regions.

Following previous empirical evidence (see, for example, Fagerberg and Verspagen, 1996; Fagerberg, Verspagen and Caniëls, 1997; Caniëls, 2000),⁸ some recent evolutionary modelling has actually pointed out that, contrary to the widespread belief and some economic theories, the impact of spatial proximity of the diffusion of technological innovation may be responsible for the reinforcement of core-periphery forces and regional divergence, especially in the presence of on-going processes of economic integration (Caniëls and Verspagen, 2001).

As widely highlighted in the literature on multinationals, the accumulation of technological competence is a path-dependent process, being partly firm-specific and partly location-specific. Multinational corporations spread the competence base of the firm, and acquire new technological assets or sources of competitive advantage. Moreover, the strategic internationalisation of technological operations has indicated that decisions on “what” and “where” to internationalise are strictly related to the roots of the firm’s competitiveness. An effective approach to the strategic management of technological functions entails the evaluation of the core technological competence – i.e. the set of knowledge, skills and capabilities that makes the firm’s innovative capacity unique and original: the locational choice is part of the strategy and a central issue to optimise technological effectiveness and growth (Chiesa, 1995). For their part, indigenous firms benefit from local knowledge spillovers from MNCs, given the access of the latter to complementary streams of knowledge being developed in other locations. The presence of a number of leading foreign-owned companies tend to attract further knowledge, to stimulate spin-offs and to generate a positive cycle: once a region establishes itself as a technology hotspot, it can experience rapid and sustainable growth. Overall regional knowledge stocks are thus very important, in so far as the cumulative nature of innovation will tend to make advantaged regions more advantaged compared to others in the next round of innovations on the basis of the accumulated knowledge stock (Malerba, 1992; Beaudry and Breschi, 2000). Yet, asset-augmenting and knowledge-seeking types of foreign investment, and the associated skills, expertise and competencies, are arguably of crucial importance as a catalyst for local growth: learning curve

⁸ Fagerberg and Verspagen (1996), for instance, considered the differences in innovative capabilities across European regions – much more pronounced than at the country level – showing that they account for a good deal in explaining the diverging trends in economic growth.

advantages are mainly people- and institution-embodied and regional systems may substantially gain from global corporations investing in innovation, technical knowledge and local human capital (Cantwell and Iammarino, 1998, 2001). On the other hand, it should be pointed out that the concentration of production and wealth in a certain location is not *per se* a sufficient condition to determine high technological growth. Innovative activities have often proved to concentrate in locations where a market for technology and innovation has evolved more fully, somehow irrespective of the spatial distribution of production and income.

As already pointed out, localisation *per se* seems to account for knowledge externalities only to a certain extent: the combination of diverse kinds of knowledge into an interdependent economic and technological base needs crucially a *plurality* of sources and *networking* among them. The features of economic systems – and particularly their communication opportunities - play a major role in assessing the conditions of the production of new technology (Patrucco, 2001a; Antonelli, 2001). In this respect, for instance, urbanised and metropolitan regions have proved to offer highly positive institutional contexts explaining the features of the collective dynamic of technological progress, due to the mix of variety and complementarity of economic activities, science and technology infrastructures and communication and network mechanisms. On the other hand, regions with a strong industrial structure, composite and advanced knowledge-production basis and intense intersectoral externalities may provide the most suitable environment for technology creation and experimentation, as well as for the development of multilateral networks of dissimilar but complementary relations between global and local actors. A deep (and widening) process of economic integration, as is the case of the European Union, has apparently enormously bolstered the need to define the problems, and the policies aimed at solving them, in terms of centre/periphery economic convergence.

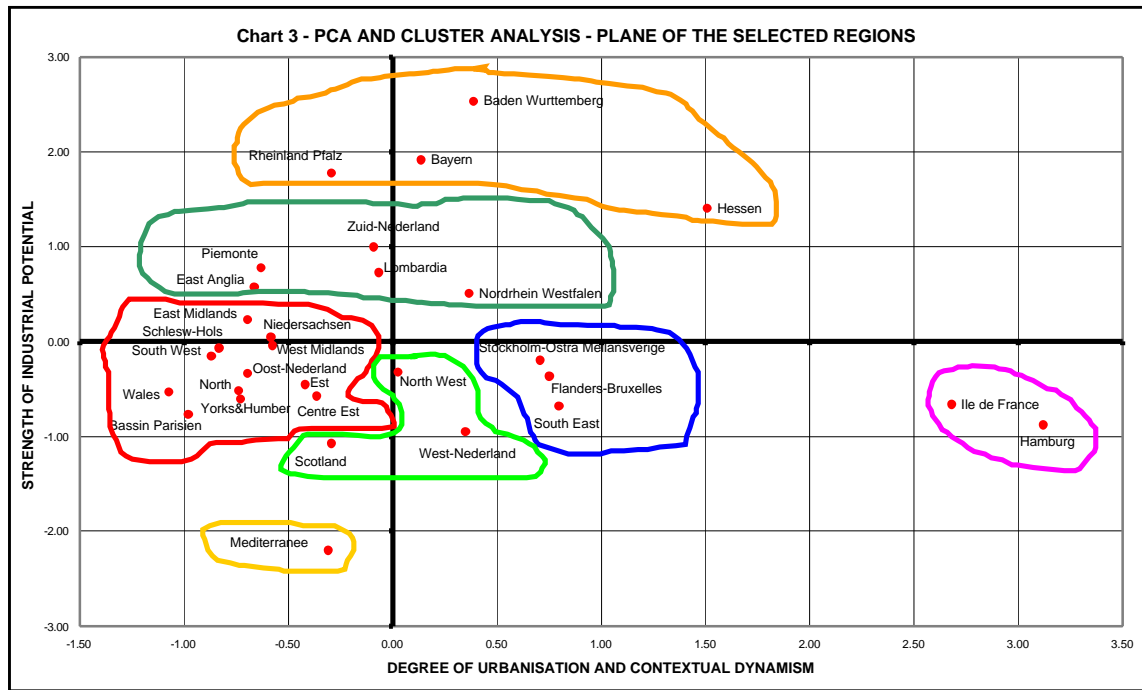
The research by Cantwell and Iammarino [49] is twofold. First, they look at the spatial distribution of both the technological operations of MNCs and overall GDP across EU regions: in spite of the relevance of corporate innovation for economic growth, their knowledge of the locational patterns at the sub-national level is still very limited. The second goal was to obtain a representation of selected regional innovation systems (RSIs) as a means of illustrating some basic links between technological growth and systemic characters.

They begin by mapping the aggregate technological activity carried out by large multinational firms in the EU regions. The complete list of sub-national units considered is reported in Appendix 1a, which records names, corresponding NUTS levels and acronyms for the 69 regions belonging to seven EU member states. The location-specific patent data were complemented through the use of other socio-economic indicators at the sub-national level provided by the EU database New-Cronos-Regio. This allowed them to build a map of MNC technological activity (patents per million of inhabitants) and GDP levels (per capita, expressed in purchasing parity standards) at the regional level, with reference to the first half of the 1990s. First of all, in line with other recent empirical analyses (Caniëls, 2000; Paci and Usai, 2000a, 2001), they showed that the degree of concentration of technological activities - as measured by the coefficient of variation - across the overall EU7's regions appears to be quite high ($CV = 1.3$) and definitely higher than that of GDP ($CV = 0.26$). More importantly, contrary to what was found by Paci and Usai (2000a), the data indicate that the regional agglomeration of the activity that underlies US patenting shows a tendency to increase over time, denoting, at first sight, the absence

of a real convergence with reference to the spatial distribution of MNC technological activity.⁹ In general terms, the geographical dispersion of MNC research is only weakly associated with the levels of economic wealth. Though the impact of national systems of innovation (NSIs) appears to emerge quite clearly from the technological proxy, NSIs are not always homogeneous entities.

The second step was to look at both the technology and economic wealth proxies in terms of growth, i.e. the percentage change of per capita GDP between 1978 and 1995 and the percentage change of US patents stocks between 1969-77 and 1987-95, always standardised to the EU average. To sum up the main observations, a rather remarkable diversity of EU systems of innovation seems to emerge both at the regional and at the national level. The UK, Sweden and Belgium turn out to be, as far as MNC patenting is concerned, relatively homogenous NSIs; however, only the regions of the latter can be identified as both technologically and economically dynamic. Whilst Dutch regions display an outstanding economic uniformity, they are highly scattered with respect to technological activity, with Zuid Nederland being by far the strongest and the fastest-growing RSI, hosting Philips's headquarters which, as is well known, has played a crucial role in shaping the Dutch NSI profile. Germany, Italy and France present a rather dualistic structure, being split between strongly innovative and technologically backward regions. This coincides also with more scattered GDP levels and rates of growth. In Italy, however, the character of the distribution of technological activities largely resembles that of an actual "polarisation" (even taking into account the different NUTS level), confirming once again the continuing huge regional imbalances of the national system.

⁹ The CV of patent counts across the 69 regions is equal to 1.6 for the first sub-period (1969-77) covered by the database, rising to 1.8 in the last sub-period (1987-95).



As a third step, they selected 30 regions for a more in-depth analysis by technological sector and over time. For the 30 selected EU regions, they searched for some classifying features on the basis of different economic and contextual indicators by means of principal component and cluster analyses (see Chart 3); they subsequently differentiated these groupings of regions in terms of “attractiveness” towards foreign innovative activity (as proxied by per capita foreign patenting activity, compared with the total overall stock 1969-95, located in each region). The correlation coefficient between the obtained clusters of regions and their proxy for attractiveness was quite high (0.7) and significant, confirming the supposition that the grouping of EU regions on the basis of the indicators reflected the distribution of foreign-owned technological activities. Moreover, it is interesting to note that the latter showed a significant correlation also with per capita GDP in 1995 (the correlation coefficient is 0.8), indicating a positive association between attractiveness and economic wealth across regions: such a relationship was not observed for the overall patent stock 1969-95 (the correlation coefficient being, in this case, 0.3). It is possible to infer that regions showing similar economic-contextual environments exhibit a tendency to cluster together with regard to attractiveness; inward flows of foreign-owned technological resources are not only highly concentrated in a few regional clusters, but also comparatively more attracted by agglomeration forces of the *urbanization* type.

Turning to technological dynamism at the cluster level, the most meaningful indication emerged from the association, across regions, between the initial MNC patent stock (1969-77) and its growth rate between the first and the last period. The correlation coefficient was indeed neither positive (technological divergence) nor negative (technological convergence), but very close to zero: therefore, it may be maintained that, over the 27 years observed, a “steady technological differential” in

overall technological growth has characterised the sub-national units.¹⁰ Furthermore, among the clusters of regions, overall technological growth appeared as closely related to that of patents in particular technological classes.

To summarize, no real technological convergence was observed among the 69 regions belonging to the seven EU countries analyzed; on the contrary, some technological divergence emerges between clusters, with the group of “industry-driven, technologically advanced manufacturing centers” increasingly favored by MNC locational choices regarding new technology creation, and “medium industrial potential, scarcely urbanised regional contexts” falling on average further behind.

The detailed geographical analysis carried out in this work supports the idea that to treat the NSI as if it was a homogenous socio-economic entity is no longer feasible. The results indicate that the regional concentration of MNC technological activities seems to have increased over time, and that the risks of assuming homogeneity increase as the gap between the most technologically advanced RSIs and both backward regions and less dynamic innovation systems has become wider. Moreover, on the basis of the above picture it can be argued that the distribution of large firms’ innovation within cluster appears to reflect, at least to some extent, economic and contextual features of EU regional systems. Some RSIs display rather fast MNC technological growth, while others – even traditionally strong innovative cores – experience a relative stagnation or decline: on the other hand, the highest degree of attractiveness towards foreign investment in research activities is found particularly in industry-driven clusters with fully evolved technological markets, or in some of the most prosperous metropolitan systems.

Assessing the overall effects of innovation and globalization

Whilst studies at the industry and firm level are crucial to understand the microeconomic aspects and many institutional features of the impact of technological change and globalisation on employment and growth, some significant feedback effects take place at the level of the whole economy. Variables such as aggregate demand, trade balance, exchange rate and interest rate act at the macroeconomic level and have an important role in the overall effect of innovation and globalisation on employment. Building on their previous research, Simonetti and Tancioni [13] have developed a model that focuses on the overall effect of innovation on employment when many feedback effects are taken into account. It has been pointed out that shocks generated in the economy by the introduction of new technology are compensated by various mechanisms that tend to bring the economy back towards full employment.

In order to assess the strength of each compensation mechanism Simonetti and Tancioni extended their previous modelling (see, for instance, the chapter by

¹⁰ It is noteworthy that the rather tiny share of MNC patenting of the remaining 39 “technologically backward” regions of the EU7 stayed fairly steady over time, having increased only by 0.5 percentage point between the first (1969-77) and the last (1987-95) sub-period here considered (from 6.3% to 6.7% of the total EU7).

Simonetti, Taylor and Vivarelli in Pianta and Vivarelli 2000). The focus is mainly on innovation, globalisation being represented by the inclusion in the models of international trade and exchange rate dynamics. Two of the four innovation models identified above are explicitly considered in the model: Product and Process innovation. ICTs are included in both product and process innovation using the USPTO patent classification, but are not separately investigated. Learning is included in the model as a time trend in the labour productivity equation, which represent the improvements in productivity unrelated to R&D-based process innovation. The model shows that process innovation is indeed labour-saving and increases labour productivity whilst product innovation is employment-generating by stimulating new demand.

Five compensation mechanisms are identified that could compensate the adverse effects of increased labour productivity on employment. In the compensation via decrease in prices a reduction in unit costs due to process innovation leads to a decrease in costs and therefore prices of the existing goods. This, in turn, leads to an increase of the demand for goods and therefore an increase in the demand for labour. Other factors, however, can dampen the effectiveness of this mechanism. First, if the innovating firms have enough market power the decrease in unit costs does not translate into a price reduction. Second, according to a Keynesian argument the effective demand might be saturated and the price reduction might not be sufficient to stimulate it. In addition, the immediate reduction in total wages caused by process innovations might depress effective demand more than the reduction in prices boosts it.

In the compensation via decrease in wages the reduction in wages that follows an increase in unemployment, the Phillip's relationship, encourages firms to use more labour intensive techniques of production thereby boosting employment. The effectiveness of this mechanism runs against three main problems. First, it might not be technically possible to substitute capital with labour. Second, following a Keynesian approach, a reduction in real wages can lead to a reduction in effective demand and to further unemployment. Third, the extent to which an increase in unemployment affects the real wage (the Phillip's relationship) depends on institutional factors, such as the role and the power of trade unions.

In the compensation via new investment, innovators reap monopoly profits that are reinvested into new ventures that create more employment. This mechanism requires that profits are reinvested and that the new investment does not increase substantially the capital intensity of the production processes.

The compensation via new machines focuses on the fact that the introduction of new process technology requires new capital goods that must be produced by some firms. If the employment created by the production of new capital goods is higher than the unemployment caused by their adoption, than the net balance is even an increase in employment. This mechanism can be effective in periods of radical change in capital goods industries or expanding demand.

Finally, the compensation via additional income is essentially a Keynesian mechanism that focuses on the role of effective demand. Innovations introduced in the economy generate new income either in the form of profits or higher wages, and

effective demand is boosted as new profits and higher wages boost consumption. If the rewards to innovation are mainly profits, however, there is a tension between this mechanism and the compensation mechanism via new investment as the profits are used to invest in new capital goods.

Results for the model run in a closed economy show that there are important institutional differences between countries. In the two Anglo-Saxon countries prices, including wages, have an important role in compensating the adverse effects of productivity increases on employment, whilst in Italy, France and Japan prices are more sticky and therefore not effective in balancing technological unemployment. In general, however, the Keynesian compensation via additional income emerges as the strongest of all compensation mechanisms across the board, with the exception of the UK, where wage determination in the labour market seems more linked to the rate of unemployment than to increases in productivity.

Using quarterly data and new econometric techniques, Tancioni and Simonetti extend the model by including both the foreign and monetary sectors of the economy. The model is estimated for the UK and Italy, and generally the results are confirmed, with the UK relying more on price flexibility and Italy more on the importance of incomes.

The model provides empirical evidence for several of the stylized facts presented above in this report. In particular, it shows that it is necessary to take technological unemployment seriously as compensation mechanisms do not provide an automatic solution to the problem. The results confirm the importance of distinguishing between different models of technological change depending on their impact on employment. The estimation clearly reveals the labour-saving nature of process innovation and the potential for employment creation of product innovation through the expansion of aggregate demand.

Another strong result of the model is that aggregate demand and income distribution play a key role in policies that aim to tackle technological unemployment, especially in some countries. In particular, the impact of income distribution on demand is a very important factor that policy makers need to take account of when formulating policy to support demand. The model also shows that it not possible to rely uniquely on labour markets to tackle technological unemployment.

The extensions to the model also have noteworthy results, with trade playing a significant part in growth and employment dynamics especially for the UK. This is not surprising as the UK is at the forefront of globalisation.

Finally, another interesting finding, which confirms the results of the closed economy model, is that new investment is more dependent on retained profits in economies with less sophisticated financial markets, such as Italy and Japan. This result has important policy implications for economic growth, which is closely linked to investment. Policy that aim to promote investment in new technologies must take into account the nature of capital markets and how firms raise the funds necessary to invest in new technology in order to make it easier for them to innovate.

Frenz, Ietto-Gillies and Girardone [4] also developed a paper examining the *relationship of innovation and internationalisation*, finding a correlation between

innovation activities and multinationality as opposed to foreign ownership. The work is based on the CIS2 financial service sector. This database was matched up with the company tree data from Dun and Bradstreet's *Who owns Whom* to account for internationalisation. The two indices of internationalisation, Ii and NSi, as developed by Ietto-Gillies were calculated for the ultimate parents of the CIS2 financial services enterprises. CIS2 was also matched up with financial data for the ultimate parent company deriving from FAME and AMADEUS. This was done in order to account for size in terms of the enterprise as well as in term of the whole group the enterprise is part of. The results show that belonging to a group and multinationality are more significant characteristics than the nationality of ownership for a variety of innovation variables in financial services from the UK CIS2.

4. Conclusions and policy implications

4.1 Implications for innovation policy

The AITEG project has led to a variety of results that have interesting policy implications. In this section some of the major findings will be briefly reviewed, drawing suggestions for innovation policy within the broader context of economic policy in Europe.

The detailed work carried out by the project on innovation indicators, linked to the dynamics of international production, has been based on the newly available Community Innovation Surveys and has opened up a new set of crucial research questions.

A first new theoretical challenge questions the idea of the homogeneous nature of innovation carried out in firms. Not only the theories of neo-Schumpeterian and evolutionary approaches, but also the rich evidence of innovation surveys now suggest that different models of innovative activities are present, and characterise particular sectors or national economies. A major cleavage has been found between innovation strategies aiming at either product or process innovation. But more refined typologies are also clearly emerging.

A second challenge questions the idea that innovation has an automatically positive impact on economic performance. Again, careful theorising, and now also empirical studies, have suggested that different innovation strategies, which characterize particular sectors, may have diverse effects on economic growth and employment patterns, and on the associated developments in international investment and production.

A third challenge is to integrate the new view of innovation in macroeconomic relations within the complex interaction of demand and supply, the web of substitution and compensation effects, and the turning points in structural change and distribution patterns.

Models of techno-economic change and areas for policy action

The need to understand the variety of innovations, the diversity of their possible effects and their complex links to macroeconomic issues is made more urgent by the current emergence in advanced economies of the new techno-economic paradigm based on Information and Communication Technologies (ICTs). The questions for theory and empirical research lead in this context to a set of policy options of great importance to European economies.

The radical change in the nature and trajectories of innovations produced by the new techno-economic paradigm is at the core of the latest, short-lived fashion in economic studies and policy, namely the infatuation with the 'new economy' (OECD, 2001). Economic developments during 2001 in the US and the world economy proved that the widespread expectations of continuing rises in stock prices, in the rates of growth of GDP and productivity, and of an 'end of business cycles' to be massively

exaggerated. The flop of the 'new economy', however, does not mean that change stops. Rather, it is likely to follow the more complex, long term route of diffusion of a new techno-economic paradigm shown by the history of the emergence of new pervasive 'technological systems' with large potential for change. Sustained and sustainable growth can be expected only once the mismatches between the new technologies and the old economic and social structures and institutions are overcome, in a two-way adjustment of the latter to the requirements of new technologies, and of re-orienting innovation and adapting it to social needs and economic demands.

From our perspective, the most important implication is the possibility of different models of innovation, depending on the constraints posed by existing economic structures, on the competencies available, on the specific strategies pursued by firms and governments. In a very simplified way, four possible innovation models can emerge, relevant for both analysis and policy.

1. *ICT focused.* In this model, innovative efforts are concentrated on the activities based on ICTs and on their applications. The technological opportunities of ICTs are the driving force of growth, although operating from a rather narrow base of technological and economic activities. The ability to extend their impact and applications across a wide range of economic activities is a key test for success.
2. *Learning based.* Here the key process shaping technological and economic change is the learning activity by people and organizations. In the place of technology-driven growth, change is shaped by the evolution of competences, by the upgrading of economic activities, production organization and human skills, and by more complex social processes related to specific economic and social priorities. This is likely to lead to different qualities of economic growth and an improved quality of employment.
3. *Product innovation based.* In the firms and industries with well established markets the opportunities of technological change can lead to a strategy based on the introduction of product innovations and the expansion of new markets, often integrating applications of ICTs. This can represent a dynamic reaction to competitive pressure, leading to growth in both production and employment.
4. *Process innovation based.* This model applies to the more traditional sectors of the economy, where the pressure from competition leads to a search for cost cutting and process innovation. Such a course is likely to lead to restructuring of firms, concentration of industries, modest growth and large job losses.

Each of these models is associated with different types of innovation and with different consequences for economic and employment outcomes. Moreover, they interact with a set of other processes affecting the sources of innovation in knowledge and learning; the global reach of technological change; the link with the economic structure and with the demand side.

The global reach of innovation

The rapid international diffusion of innovations and the increasing competition on more open markets are changing the shape of the innovation and production systems found within national boundaries. The ability of firms and organizations to benefit from the technological opportunities offered from globalisation is crucial for obtaining higher economic growth. Conversely, globalisation can reduce the production and employment base of advanced countries when the technological advantages are eroded faster than they are renewed.

The link with structural change and economic performance

In periods of changing techno-economic paradigms, the inherited economic structure of a country and its ability to undergo wide ranging structural change are crucial factors shaping its growth prospects. The strains of change on national economies are higher, the greater is the extension of traditional industries facing restructuring or decline. Growth opportunities are higher in countries where new fast growing sectors, in both manufacturing and services, are more important. The sectoral structure of economies is therefore an important factor, which can help explain differences in national economic performances. Its weight is emphasized by the process of globalization, which exacerbates competition and makes more evident the relative advantages associated with 'structural' competitiveness and the disadvantages associated with traditional industries.

The importance of new demand

In the current context of slower growth and sluggish demand in Europe, a major mismatch is now found between the high potential of new ICT-based products, offering more various and 'personalized' goods and services, and the lack of emergence of new large markets with strong demand. The slow learning processes in consumption, the need for social innovations (particularly in the use of time) required to 'match' the opportunities of technological innovations, the lack of appropriate institutions and public policies managing such problems are all factors which may explain such a mismatch. But a more direct economic factor is important, associated with the current distribution of incomes and the reduction of the wage share. The strong polarization pattern, most extreme in the US, but clearly present also in Europe, has reduced the aggregate demand effects and has prevented the emergence of a large demand for new ICT-based products from wage-earners. Therefore the prospects for growth also depend on the ability of national governments and of the EU to engineer a sustained new demand, consistent with the potential of the economic structure.

The variety of these factors, the differences in innovation models and the distinct strategies which can be pursued by firms and governments suggest that no automatic link can be expected between innovation and growth performances in the context of the current changes in technologies and economic structure. Far from being a deterministic process, the economic and employment outcomes of specific models of technological change are the result of social processes, where institutions, government policies and social relations play a major role, alongside the developments in

technology and the strategies of firms. The challenge for economic research on innovation is to develop a more solid understanding of these issues, relationships and contexts, advancing at the same time theory and empirical research.

Stylized facts and policy implications

A number of policy implications emerge from the AITEG research efforts, broadly consistent with other recent work investigating similar problems, including Vivarelli and Pianta (2000), Fagerberg, Guerrieri and Verspagen (2000), and Petit and Soete (2001). The stylized facts, regarding the impact that innovation has on economic performance and employment, which emerge from this empirical research can be summarised as follows.

1. *Technological unemployment* cannot be neglected as a possible outcome of current technological change, especially in Europe. There is no automatic mechanism ensuring that a national economy is able to fully compensate for innovation-related job losses.
2. *Aggregate demand* and macroeconomic conditions play a key role in creating the conditions for a positive impact of technological change not only on employment levels, but also on income distribution and other consequences of economic change.
3. *Labour market conditions* obviously play a role, as do country specific institutions and social relations. However, there is little evidence that either wage levels or ‘rigidities’ can explain by themselves much of the employment change that has occurred in Europe; on the contrary, structural factors remain crucial.
4. *The sectoral structure* of the economy is important. The sources of job creation and destruction are specific for individual manufacturing and service industries and such structural factors are important determinants of countries’ employment performance. This is particularly important as the activities based on ICTs and characterizing the ‘new economy’ are highly concentrated in just a few countries.
5. *The type of innovation* is important, with different effects resulting from alternative strategies. Product innovation generally has a potentially positive employment impact, while a negative one is found for process innovation. The overall effect of the technological change recorded in European manufacturing industry in the 1990s has generally been a labour-saving one.
6. *The role of services and ICTs* is crucial. New services and ICT-based activities have a positive impact on growth and jobs, while in other services labour-saving new processes dominate, at least from the limited evidence available for selected countries.
7. *The skill bias effect* is relevant. Within the trend towards a quantitative reduction of manufacturing jobs in Europe, an upskilling process is evident.

Blue collar and low skilled jobs have fallen rapidly, while higher skilled jobs have been created, although with a highly uneven pattern across countries, industries and firms.

8. *International production* is associated with innovation and productivity growth. As innovation has an increasingly international reach, a two way link between foreign investment and technological and output performance can be found in multinational firms.

The failure of current policies

Two key principles for policy emerge from such evidence (see also Vivarelli and Pianta, 2000): first is the need for *targeting* the industries with the greater potential for growth and employment, and for specific actions directed at the needs of individual industries; and second is the need for a strong *coherence* between industrial, technology, learning and macroeconomic policies.

There is a strong interaction between technological, structural, demand and learning factors, but the main objectives and mechanisms of policy formulation in each of these fields are contradictory and fragmented, with little positive impact on growth and employment.

In contrast to such needs, current policies, at the national and European levels, have given priority to other issues, resulting in unsatisfactory performances and inadequate adjustment to technological and economic change. The key limitations of current policies can be summarized as follows:

- i) *Macroeconomic policy* has been dominated in the last decade in Europe by a deflationary bias.
- ii) *Industrial policy* has been largely abandoned in most countries, and turned into competition policy. There is a decreasing scope for the pursuit of competitiveness as an employment strategy.
- iii) *Innovation policy* has been confined to a "supply push" approach, funding R&D and favouring the diffusion of innovations and investments embodying new technologies, leading to labour-displacing process innovations, often with little effectiveness.
- iv) *Learning policy* has still little interaction with the new developments in technologies and firms' needs, leading to skill mismatches.

Policy recommendations

New policy directions can emerge from such evidence (as argued also in the concluding policy considerations of Vivarelli and Pianta, 2000).

i) A new macroeconomic policy. Needs an active and selective demand policy, providing a coherent context for industrial and innovation policy. However, heavy constraints are put by the terms of the European Monetary Union.

ii) A targeted industrial policy. Has to focus on the activities (often ICT-related) with highest growth, network externalities, capacity for learning and product innovations, combining supply and demand measures, including:

- long-run strategy for repositioning the economy in the international division of labour;
- the provision of infrastructures and framework conditions for new sectors, new markets and new products;
- organizing private and public sector demand with incentives and procurement;
- action on regulatory and competition aspects, opening access for new producers; and
- managing the contraction of declining industries, not just through income support policies, but with new activities.

iii) A targeted innovation policy. In order to achieve long term growth and reduce unemployment, more attention has to be paid to the ability to innovate in technologies, organisations and institutions. Three main aspects can be discussed in this context:

a) Focusing on employment friendly innovations

The distinction between product and process innovations plays an important role in shaping the economic and employment outcomes of technological change and should inform policy in this field. Supply-side incentives and funds for innovation should introduce a clear focus on the type of innovative activities more likely to result in new products, rather than in labour-displacing new processes. It should be clear that continuing with a policy of indiscriminate financial support for supply-driven innovation by firms might lead to major direct losses in employment.

However, the discrimination in favour of the innovative activities likely to lead to product innovation can hardly be introduced at an early stage of the innovation process, where new generic knowledge is produced. The key for innovation policy is to focus on the applications of new technologies that can lead to new products. For instance, the relative incentives between carrying out R&D, design or trial production on the one hand and introducing innovation-related investment has to be tilted in favour of the former. Moreover, as argued below, the policy tools should operate much more on the demand side, focusing on new potential markets and the role of users.

b) The potential of ICTs

A modest rate of product and service innovation, a slow pace of change in demand and a slow learning by users and consumers, are all factors that are likely to contribute to slow down the development of the new ICT-based markets. Another, more fundamental reason, however, is the mismatch and lack of coordination between the technological, organisational, institutional and social innovations which are required for the successful emergence of a new technological paradigm. Therefore, attention has to be paid to the social arrangements concerning in particular the role of learning (see below), the use of time and the ways of stimulating the emergence of new activities addressing unmet needs.

c) Introducing demand pull policies and focusing on the users

So far, the evolution of most ICT activities has been driven by the design of suppliers rather than by the requirements of the users, resulting often in a limited expansion of new activities and in an unrealised potential of the new technologies. The “technology push” which in past decades has created countless innovations in ICTs appears now as a straitjacket for the expansion of economic activities based on ICTs, as what is lacking now are, on the one hand, the coordination and coherence of organisational, institutional and social innovations and, on the other hand, the operation of a “demand pull” able to launch the growth of new large markets for new goods and services (some of these issues are also addressed in High level expert group, 1997). This “demand pull” should rely not so much on old-style public procurement, but rather on new schemes “empowering the users”, which might accelerate the development of markets for new goods and services, able to address existing specific social needs. In such a view, public procurement should abandon untargeted demand-led schemes and foster a very selective public expenditure focused on ICT new products (the state should transform itself from a “blind consumer” to an “intelligent consumer”).

These appear to be the key policy challenges raised by the emergence of ICTs for structural change. Ignoring them and concentrating on “framework conditions” for innovation and the operation of firms means in fact leaving to large firms and markets to sort out the future of European industry, in a rather naive application of free-market recipes.

iv) A new learning policy. The new generation of policies should be less dirigistic, tailor made to the specific economic conditions of regions, countries, industries, technologies and social groups

- Has to avoid the simplistic request for an educational system closer to the short-term needs of firms; a broad view of learning is needed.

- Incentives should be provided to firms and individuals (higher wages, tax deductions, etc.) to expand their competences and "human capital" in a comparable way to what happens for physical capital.
 - Specific actions are required for the problems of the low skilled.
- v) *A new distribution policy.* The *distribution of the productivity gains* resulting from technological change has to become part of the policy process. Policies need to address not just the achievement of productivity gains made possible by new technologies, but also the pattern of distribution of such gains. Over the past decades, innovation has mainly benefited firms and consumers, in the form of higher profits and lower prices, in a context of increasing pressure on firms from increasing international competition and from investors demanding high financial returns. Workers have seen job losses, frequent reductions in real wages, increased insecurity, increased work intensification, and often increased working time. The result has been an increasingly uneven distribution of incomes, made worse by the reduction of resources available for social redistribution through the tax system. If we want to reap the benefits promised by the new technologies, it is vital that these negative trends be reversed through the pursuit of a new generation of policies.

More generally, two additional aspects deserve close attention:

- *Institutional innovations*, consistent with the new nature of technological change, are required in order to reap all the benefits promised by the diffusion of ICTs and to redistribute them efficiently and effectively across society.
- *Appropriate levels for policy actions* are required: actions by national governments need be integrated at the regional, European and global level, overcoming some of the limits of traditional policies implemented in the past.

4.2 Implications for globalisation policy

As discussed by Lee, globalization is not a case of national systems becoming redundant and companies having to adapt to a simple global marketplace. It is a process where existing systems are operating at an increasingly international level. These different systems and structures may clash and may produce new outcomes, but none of this is naturally or technologically predetermined. How these processes are actually worked out is discussed in the globalisation research for the AITEG project. Research such as that by Balcer and Enrietti illustrates this phenomenon at the corporate level. While Molero, and Cantwell, Dunning and Janne illustrate this in terms of their relations to national systems. In uncovering the detail beneath the generalisations around 'globalisation', Cantwell *et al.* demonstrate not only that there is an important role for public policy, but that this needs to be much more nuanced and targeted than is often the case at present. There are issues not only of what type of

inward investment might be most beneficial, but also of how to then maximise the benefits and minimise the costs that result from such flows.

The results from the AITEG research taken together have the following implications for globalisation policy.

1. *Internationalisation policies must be seen in the context of industrial policies.* The integration process within the EU is spearheaded by the largest TNCs and is also in their interest in terms of the size of the market. The extent to which companies originating from EU countries will be encouraged and sustained in their internationalisation strategies has to be closely linked to their sector-specificity.
2. *Governments should follow policies of enhancement of countervailing transnational power among those actors who are still lacking such power, for example labour, consumers and unnational companies, particularly SMEs.* This policy is necessary because it has been suggested that a strategy of international locational diversification gives strong advantages to companies in terms of risk spreading and mainly in terms of the acquisition of a strong bargaining position towards labour and governments. Some problems derive from the fact that truly transnational institutions that plan, organise, and control resources and activities across different nation-states, face actors which for historical reasons or by their own nature are not (or not yet) able to operate across countries to the same extent.
3. *At least on the European level, government policy should not be diverted down a simplistic goal of just attracting as much inward investment as possible, away from other 'competitor' economies.* The benefits of such investment will depend precisely on the extent to which productive co-operation is forged with other firms and institutions domestically and internationally.
4. *National governments need to focus on how to upgrade their own domestic economies.* This will maximise the effect of footloose capital and transnational economic organisation,
 - a) Firstly, this will maximise the chance of domestic firms being able to forge international links and benefit from them.
 - b) Secondly the domestic economy will thereby prove attractive to the sort of inward investment that is likely to contribute rather than just take advantage of the domestic economy.
 - c) Thirdly, it will maximise the beneficial impact that such investment is likely to have in terms of linking with domestic firms and contributing positively to the existing national systems of innovation.
5. *There is also a need for the development of statistics that take account of the ICT-intensity of products and processes on the industrial classification side.* While on the side of international data we need statistics on the various

delivery modes including the electronic ones. Despite being an important area of academic research with clear policy implications at both the corporate and governmental levels, there is not yet a great deal of internationally comparable, time series data. Indeed, the need for data work was one of the motivations behind the 2000-2002 AITEG project, one outcome from which has been a much more comprehensive and comparable data set than was previously available.

Unemployment in Europe over the past 20 years and more is clearly not the result either of a simple process of new technology replacing workers, nor of jobs being lost to the developing countries as a result of globalisation. However, the processes by which jobs have been lost do in most cases involve corporate restructuring which cannot be divorced from either innovation or global economic processes. Even the seemingly separate depressing effect of fiscal and monetary policy has been inextricably linked with the EU's attempt to create an economic block able to compete – or create the economic basis for EU firms to compete – globally. The policy implications therefore have strong parallels with many existing policy agendas, namely the creation, support and development of dynamic and innovative economic networks and districts. The success of such networks and districts, and of the firms that form them and are connected to them, can have positive spill-over effects not just to other parts of the domestic economy but also internationally. Public policy is therefore not a zero-sum game, where one economy can only benefit at the expense of another. As the Cambridge economist Joan Robinson put it, the worst of all bad neighbourly policies is to go into recession.

By pursuing positive employment and growth strategies, individual countries not only help themselves but also help others, and likewise they benefit from other governments seeking to upgrade their own domestic economies. By investing in the physical and productive infrastructure, and in the workforce, and by pursuing productive co-operation between firms and other institutions, economic growth and employment can be enhanced at the regional, national and international level. These are policies that can and should be pursued by governments at all these levels, and also by the international institutions such as the European Commission. The EU's Regional Innovation Strategies and other such initiatives become more important, not less, with the advance of globalisation. Such policies not just ensure the maximum economic benefits within the new economic environment; they help to shape and develop that environment itself. Globalisation is not a given. It represents the current configuration of economic relations that have resulted from past policy action. The form of globalisation in the future will depend on public policy action now. It could develop as a global free-for-all, in which governments compete against each other for investment and jobs, while undermining the long term basis on which such investment and employment depends, of a dynamic domestic market. Or it could develop along a high road of productive co-operation, high international standards, asset augmenting FDI, and dynamic and innovative regional economies and national systems of innovation. All these positive factors are shown in several of the AITEG papers (all of which are listed in Section 5 below) to play an important role at present in encouraging firms to invest and innovate (e.g. Hesselman on the role of standards) or to be an important outcome (e.g. Cantwell *et al.* on asset augmenting FDI). But the AITEG research also suggests firstly that the necessary policies are currently being pursued inadequately, and secondly that the positive outcomes are being achieved in

some cases but certainly not all. There remains a huge untapped potential for improved economic performance and employment outcomes at the European – and global – level.

5. Dissemination and/or exploitation of results

No.	Title	Author(s)	Partner	WP	Exploitation of Results
1	<i>Technology, Growth and Employment</i>	Corley, M, J. Michie, and C. Oughton	1	1	Published in Special Issue of <i>International Review of Applied Economics</i>
2	<i>Patterns of innovation in UK industry: exploring the CIS data to contrast high and low technology industries</i>	Cox, H., Frenz, M. and Prevezer, M.	1	4	Published in Special Issue of <i>Journal of Interdisciplinary Economics</i>
3	<i>Innovation and Performance in British-based Manufacturing Industries: Shaping the Policy Agenda</i>	Cox, H. and Frenz, M.	1	4	Published in <i>The Business Economist</i> , 33 (2).
4	<i>The role of multinationality and foreign ownership in innovation. An analysis of the Community Innovation Survey 2 for the UK financial services.</i>	Frenz, M, Ietto-Gillies, G. and Girardone, C.	1	9	Presented at the 12 th International Conference of RESER the European Network of Economic and Spatial Service Research, Manchester England, 26-27 th September 2002.
5	<i>Assessing the international spread of the world's largest TNCs</i>	Frenz, M and Ietto-Gillies, G.	1	4	United Nation's World Investment Report, 2001
6	<i>A Description of Responses to the UK Community Innovation Survey2</i>	Hesselman, L	1	3	Published in Special Issue of <i>Journal of Interdisciplinary Economics</i>
7	<i>How internationalized are the EU largest transnationals? Comparative analysis and implications</i>	Ietto-Gillies, G.	1	5	Published in Special Issue of <i>Journal of Interdisciplinary Economics</i>
8	<i>Internationalization and the demarcation between services and manufactures. Theoretical and empirical analysis</i>	Ietto-Gillies, G.	1	5	Forthcoming in, <i>The Internationalization of Services</i> ,edited by Miozzo and Miles, CRIC Manchester University and UMIST.
9	<i>Globalisation and the Diversity of National Institutions</i>	Lee, SH	1	6	Published in Special Issue of <i>Journal of Interdisciplinary Economics</i>
10	<i>Innovation and the Economy</i>	Michie, J, C. Oughton and M. Pianta	1,4	1	Published in Special Issue of <i>International Review of Applied Economics</i>
11	<i>Globalization and Economic Performance</i>	Michie, J, C. Oughton, and M. Ramirez	1	1	Published in Special Issue of <i>Journal of Interdisciplinary Economics</i>
12	<i>Globalization, Growth and Employment</i>	Michie, J, C. Oughton and A. Zanfei	1,4	1	Published in Special Issue of <i>Journal of Interdisciplinary Economics</i>
13	<i>A Macroeconometric Model for the Analysis of the Impact of Technological Change and Trade on Employment</i>	Simonetti, R and M. Tancini	1	9	Published in Special Issue of <i>Journal of Interdisciplinary Economics</i>

14	<i>The Role of Technology and Competitiveness Policies</i>	Fonfria, Guardia and Alvarez	2	4	Published in Special Issue of <i>Journal of Interdisciplinary Economics</i>
15	The technological role of Telefonica before and after its privatization: an approach to the Spanish networks of telecommunication in the last quarter of XX century	López, S.	2	4	Presented at the International Conference on the History of Presented at: (1) Computing and Networks Conference, Grenoble, France 25-27 November 2002 and (2) Encuentro de Segovia 2002. Complutense University, Valladolid University, and Salamanca University. Segovia 3 de julio de 2002.
16	<i>Spanish TLC's Companies: a study case of the innovative firms of network components</i>	López, S. and G. Zlatanova	2	4	Presented at seminar in Lisboa under STRATA Thematic Network MESIAS, January 2002. This working paper is also part of the Goritza Zatlanova's PhD which will be defended next September and serves as the basis of a possible English publication.
17	<i>The Internationalization of the Spanish Telecommunication Industry</i>	López, S. and A. Pueyo	2	4	Presented at Internacionalización tecnológica y empresas multinacionales. Nuevos retos para las políticas de innovación. El Escorial – Complutense University (Madrid), 22 al 26 de julio de 2002. Part of the paper will also be used for the Ana Pueyo's doctoral thesis.
18	<i>The Innovative Behaviour of MNC Subsidiaries in Uneven European Systems of Integration: A Comparative Analysis of The German and Irish Cases</i>	Molero, Zayas J.	2	4	Published in Special Issue of <i>Journal of Interdisciplinary Economics</i> . Also presented at seminar in Brandenburg under STRATA Thematic Network MESIAS, April 2001.
19	<i>Difference of innovative behaviour between national foreign firms: measuring the impact of foreign firms on national innovation systems.</i>	Molero Zayas, J. and Heijs, J.	2	7	Published in <i>International Journal of Entrepreneurship and Innovation Management</i> , Volume 2 N° 2/3, pp.122-145,(2002) This paper was also presented in a seminar in Budapest under STRATA Thematic Network MESIAS, March 2001.
20	<i>Employment and innovation in services: Knowledge Intensive Business Services in Sweden</i>	Nählinger, J. and L. Hommen	3	4	Working paper, Linköping: Department of Technology and Social Change, Linköping University
21	<i>How innovative is Swedish industry? A factor and cluster analysis of CIS II.</i>	Sellenthin, M. and L. Hommen	3	4	Published in Special Issue of <i>International Review of Applied Economics</i> .
22	<i>Employment effects of product and process innovations in Europe</i>	Antonucci, T. and M. Pianta	4	3	Published in Special Issue of <i>International Review of Applied Economics</i>
23	<i>The Technological Performance of Europe in a Global Setting</i>	Archibugi, D. and A. Coco	4	6	Published in <i>Industry and Innovation</i> , Vol.8, no.3, pp.245-266, December 2001
24	<i>A New Indicator of Technological Capabilities for Developed and Developing Countries</i>	Archibugi, D. and A. Coco	4	6	Forthcoming Publication
25	<i>The Globalisation of Technology and its Implications for Developing Countries.</i>	Archibugi, D. and C. Pietrobelli	4	6	Forthcoming Publication

26	<i>The Impact of Focused Globalisation in the Italian Automotive Industry</i>	Balcer and Enrietti	4	6	Published in Special issue of <i>Journal of Interdisciplinary Economics</i>
27	<i>Investimenti all'estero e produttività. Un'analisi comparata di Italia, Francia e Spagna"</i>	Barba Navaretti , D. Castellani and A. Zanfei	4	3	Published in <i>La competitività dell'Italia. Ricerca del Centro Studi Confindustria</i> . Volume II.: le imprese, Giampaolo Galli and Luigi Paganetto (eds), Il Sole 24 Ore, Milano, March 2002
28	<i>Firms' Technological Trajectories and the Creation of Foreign Subsidiaries</i>	Castellani, D.	4	3	Published in Special issue of <i>International Review of Applied Economics</i>
29	<i>Export behavior and productivity growth: evidence from Italian manufacturing firms</i>	Castellani, D.	4	5	Working Paper in Quaderni di Economia, Matematica e Statistica, Università di Urbino, n. 60, 2001. This is also under revision for <i>Weltwirtschaftliches Archiv</i>
30	<i>Multinational firms, Scale Economies and Learning-by-Investing. Evidence from a panel of Italian manufacturing firms</i>	Castellani D.	4	5	Working Paper in Quaderni di Economia, Matematica e Statistica, Università di Urbino, n. 61, 2001
31	<i>Export behavior and productivity growth: evidence from Italian manufacturing firms</i>	Castellani, D.	4	5	Presented at: (1) European Association of Development Institutes (EADI) on 'Small Enterprises in Global Markets: Exports, Clustering and Innovation', 22-24/3/2001; (2) Università del Molise, Campobasso, European Association of Industrial Economists (EARIE), Trinity College, Dublino 30/8/2001 - 2/9/2001; (3) Conference on "Imprese, sistemi locali, paesi. La nuova competitività nell'età dell'Euro" Urbino, 22-23/6/2001
32	<i>Sectoral Patterns of Inwards FDI and Domestic Productivity in Europe</i>	Castellani, D. and A. Zanfei	4	5	Published in Special Issue of <i>Journal of Interdisciplinary Economics</i>
33	<i>Multinational companies and productivity Spillovers: is there a specification error</i>	Castellani, D and A. Zanfei	4	5	Presented at: (1) Univ of Trento, Dept. of Economics, 13/3/2002 and (2) European Economic Association Conference, Venice, 22-28/8/2002. SSRN working paper, http://papers.ssrn.com . Also submitted to The Economic Journal
34	<i>Technology Gaps, Absorptive Capacity and the Impact of Inward Investments on Productivity of European firms"</i>	Castellani, D and A. Zanfei	4	5	Presented at CNR Study group on International Economics and Economic Development on " <i>Integrazione Commerciale, Integrazione Produttiva e Competitività nel Quadro dell'allargamento ad Est dell'Unione Europea</i> " held in Milan, 16-17/11/2001. Also <i>Economics of Innovation and New Technology</i> , forthcoming
35	<i>Fiat Auto Poland and its Suppliers</i>	Enrietti, A	4	6	Paper presented at the MIT SOFI WZB Workshop: <i>European Industrial Restructuring in a Global Economy: Fragmentation and Relocation of Value Chains</i> , Berlin Nov.30/Dec.1 2001

36	<i>The impact of innovation on employment in services. Evidence from Italy</i>	Evangelista, R. and M. Savona	4	4	Published in <i>International Review of Applied Economics</i>
37	<i>Innovation, employment and skills in services. Firm and sectoral evidence</i>	Evangelista, R. and M. Savona	4	4	Presented at ECIS Conference The Future of Innovation Studies Eindhoven Center for Innovation Studies, 20-23 September 2001. Also submitted to <i>Structural Change and Economic Dynamics</i> .
38	<i>L'impatto dell'innovazione sull'occupazione nei servizi. Un'analisi dell'indagine ISTAT</i>	Evangelista, R, G. Perani, and M. Savona	4	4	Submitted to <i>La rivista Italiana degli economisti</i>
39	<i>How "provincial" is your human capital? Effects on employment and economic performance of European regions</i>	Gambardella, A, M Mariani and S Torrissi	4	6	Forthcoming Publication
40	<i>Diversity of Innovation in Europe</i>	Nascia and Perani	4	3	Published in <i>International Review of Applied Economics</i>
41	<i>Innovazione tecnologica, occupazione e sviluppo: un confronto internazionale</i>	Pianta, M.	4	3	Published in <i>Accademia dei Lincei, Tecnologia e società. I. Tecnologia, produttività, sviluppo, atti del convegno, Roma, 11-12 Dicembre 2000, Accademia dei Lincei, Roma, 2001, pp.31-47</i>
42	<i>Instabilità e asimmetrie del nuovo paradigma</i>	Pianta, M.	4	3	Published in <i>Economia e Politica Industriale</i> n.112, 2001, pp.59-66.
43	<i>Cambiamento tecnologico e politiche per l'occupazione</i>	Pianta, M, M.C. Piva and M. Vivarelli	4	3	<i>Quaderni di Rassegna Sindacale. Lavori e imprese nella nuova economia. n.1, 2001, pp.75-84.</i>
44	<i>The Skill Bias: Comparative Evidence and an Econometric Test</i>	Piva and Vivarelli	4	3	Published in Special Issue of <i>International Review of Applied Economics</i>
45	<i>International production in Italy: evidence from firms and local systems in traditional industries</i>	Schiattarella, R and S. Rossetti	4	6	Forthcoming Publication
46	<i>Firms' Technological Trajectories and the Creation of Foreign Subsidiaries</i>	Castellacci, F.	5	3	Published in Special Issue of <i>International Review of Applied Economics</i>
47	<i>National absorptive capacity and the stage of development</i>	Criscuola, P and R. Narula	5	7	Working paper that serves the basis of doctoral thesis for Paola Criscuola.
48	<i>Evolution of Multinational Corporate Technological Systems in the UK and US</i>	Cantwell, J, J. Dunning and O. Janne	6	8	Published in Special Issue of <i>Journal of Interdisciplinary Economics</i>
49	<i>MNC Technological Activities and Economic Wealth. An Analysis of Spatial Distribution in the European Union</i>	Cantwell, J.and S. Iammarino	6	8	Presented at: (1)Univ of Turin, Dept of Ecns, 11/12/2001 Turin; (2) Univ of South Bank, Centre for Intl Business Studies, 06/02/2002 London; (3) University of Cambridge, Judge Inst of Mgmt Studies, 21/02/2002 Cambridge;(4) Conference on "Regional Disparities in the Mediterranean area", IREM-National Research Council, 21/03/2002 Naples; (5) University of L'Aquila, Dept of Ecns, 12/06/2002 L'Aquila; (6) 6th Intl Conference on Technological Policy and Innovation-Kansai 2002,12-15 Aug 2002 Kyoto, Japan.

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7. Annexes

Annex A. List of Project Deliverables.

The list of project deliverables of any tasks completed during the relevant period, and which constitute contractual deliverables, should be given with indication of the references and issue date in comparison with the project planning and the Technical Annex to the contract (sometimes called the Work Programme).

As mentioned in the 24-month report, the deliverables in the original proposal indicated that the project would deliver, among other things 1) the manuscripts of two books with analytic research results and 2) a manuscript of a wide audience book with summary and policy results. After careful consideration, the AITEG team members decided to instead publish the project output in the special issues of two journals: *The Journal of Interdisciplinary Economics* and the *International Review of Applied Economics*, one of which (*The Journal of Interdisciplinary Economics*) is a triple issue. This decision was made because it seemed preferable to publish all of the papers in the two journals with an ‘overview’ piece to each of these as an introduction, rather than to publish in two books with a ‘third’ overview book. Additionally, the offprints of the two overview/introductory pieces will be circulated to journalists, policy makers and others.

With the exception of this deviation from the proposal, the specific activities undertaken during the project have generally kept to their originally proposed format and timetable.

Deliverables list

No	Delivery title	Proposed delivery date month	Actual Delivery
1	Planning Conference	1 st	1 st
2	State of the art report: WP1	5 th	7 th
3	Report on identification of theoretical and methodological question for research: WP2	5 th	7 th
4	Research Conference	8 th	8 th
5	Intermediate Report on The Impact of Technological Change	13 th	13 th
6	Intermediate Report on The Impact of Globalization	13 th	13 th
7	Working Papers from WP 3 to 5	13 th	14 th
8	Synthesis Conference	14 th	14 th

9	High level meeting with national policy makers	14 th	8 th
10	National Dissemination Workshops	18 th	21 st
11	European Policy Workshop and Ending Conference	22 nd	25 th
12	Policy Memorandum	22 nd	25 th
13	Manuscripts of two books with analytic research results*	24 th	27 th
14	Manuscript of a wide audience book with summary and policy results*	24 th	27 th

* See note in introduction to Annex

Annex B. Conference Presentations

1. AITEG Planning Conference, Birkbeck, University of London, London 27th March 2000

The first planning conference of AITEG took place at Birkbeck, University of London on 27th March 2000. A briefing paper was distributed on the structure and sequence of the Work Packages, which emphasized Work Package deadlines, national dissemination workshops, policy workshops and conference dates throughout the course of the research. The briefing also set out how various research teams were involved in the different Work packages, and indicated the different phases of the project in which they were to contribute.

A synthesis of the project's overall approach was presented, which set out the analysis of innovation and globalization in terms of general concepts, models, and specific effects on firms, industries, and on the aggregate economy. The aims of the analysis were specified and levels of analysis were identified, involving the innovation survey, industry cases, and different forms of globalization. More generally, data from the technological context and the system dimension were emphasized and two workshops on globalization and innovation relating to employment and growth were organized.

List of London Conference Presentations:

ROBERTO SIMONETTI AND MASSIMILIANO TANCIONI

Modelling the joint impact of innovation and globalisation on employment and growth.

JOHN CANTWELL AND SIMONA IAMMARINO

European regions and multinational corporations: change, stability and strengthening of technological comparative advantages.

HOWARD COX, SIMON MOWATT AND MARTHA PREVEZER
Networks, Innovation and Information Control: the Case of the Food Processing and publishing sector in Britain.

L. NASCIA AND GIULIO PERANI
A cross-country analysis of European innovative activity: some evidence from Eurostat data.

DAVIDE CASTELLANI
Outward investments, learning and employment. Micro-dynamic evidence from a panel of Italian firms.

CASTELLANI, DAVIDE AND ANTONELLO ZANFEI
Inward investments and productivity spillovers.

List of London Conference Participants:

Birkbeck College

Ms Francesca Beausang
Professor Jonathan Michie
Dr Christine Oughton
Dr Maura Sheehan
Dr Roberto Simonetti
Dr Vincenzo Spiezia

South Bank University

Dr Howard Cox
Professor Grazia Ietto-Gillies
Dr Martha Prevezer
Dr Simon Mowatt

Universidad Complutense, Madrid

Dr Santiago Lopez

University of Linköping, Sweden

Professor Charles Edquist
Dr Leif Hommen

Universita di Urbino, Italy

Mr Tommaso Antonucci
Dr Davide Castellini
Professor Giovanni Balcet
Dr Also Enrietti
Dr Rinaldo Evangelista
Professor Alfonso Gambardella
Dr Myriam Mariani
Dr Giulio Perani
Professor Mario Pianta
Ms Maria Savona
Professor Roberto Schiattarella

Mr Massimiliano Tancioni
Dr Salvatore Torrisi

University of Oslo, Norway
Professor Jan Fagerberg
Dr Terje Gronning
Rajneesh Narula

University of Reading, UK
Professor John Cantwell
Dr Simona Iammarino

University of Oslo, Norway
Professor Jan Fagerberg
Dr Terje Gronning
Rajneesh Narula

University of Reading, UK
Professor John Cantwell
Dr Simona Iammarino

2. AITEG Policy and Research Conference, Rome, 12-14th October 2002

On the occasion of the Project conference on October 13-14th 2000 in Rome, a dissemination and policy discussion on the theme “Globalisation, Technological Change, Employment. Facts and Policies in Italy and Europe” took place on October 12, 2000. A broad audience (100 people) of scholars, business and trade union representatives, local and national policy makers was present, including the Italian Undersecretary of the Ministry of Scientific and Technological Research, the head of FIAT economic research and the Head of the Economic Policy Unit of the Italian Prime Minister’s Office.

The second research conference of AITEG was held on 13-14th October 2000 in Rome, Italy organized by Università di Urbino. Contributions from each of the project teams were discussed and the structure of the overall project was clarified.

In particular the necessity of linking the case studies to the common framework was stressed as well as the need for each research project to be integrated to analyse the impact of technological innovation and globalisation.

The integration of the quantitative and qualitative data on innovation and globalisation was discussed, with regards to the Community Innovation Survey and data in the Who Owns Whom Database (WOW).

List of Rome Conference Presentations:

Working papers 1 and 2

DANIELE ARCHIBUGI

The Globalization of Innovation and the European innovation system

PAOLA CRISCUOLO AND RAJNEESH NARULA

Cross-country and cross-firm knowledge flows: R&D investments of European MNEs in the US.

JOSE MOLERO, JOOST HYES AND MANUEL GAMEZ

The differentiated impact of innovative strategies of MNEs and domestic firms on National Systems of Innovation: an exploitation of the CIS

GIOVANNI BALCET G. AND ALDO ENRIETTI

Case study on the internalisation of Italy's auto industry.

GIOVANNI BALCET AND RINALDO EVANGELISTA

Innovative Activities and Technological Spillovers of Multinational Affiliates in Italy

ALFONSO GAMBARDELLA, MYRIAM MARIANI AND SALVATORE TORRISI

How "provincial" is your human capital? Effects on employment and economic performance of European regions.

TOMMASO ANTONUCCI AND MARIO PIANTA

Technological activities and economic performances

CHARLES EDQUIST, LEIF HOMMEN AND MAUREEN MCKELVEY

Product and process innovation and employment

RINALDO EVANGELISTA, GIULIO PERANI AND MARIA SAVONA

Technological change and employment in services.

List of Rome Conference Participants:

Birkbeck, University of London

Ms Paola Criscuolo

Prof. Jonathan Michie

Dr Christine Oughton

Dr Roberto Simonetti

South Bank University

Prof. Howard Cox

Ms. Linda Hesselman

Dr. Claudia Girardone

Universidad Complutense, Madrid

Prof. Jose Molero

University of Linköping, Sweden

Dr Leif Hommen

Universita di Urbino, Italy

Mr Tommaso Antonucci
Dr. Daniele Archibugi
Prof. Giovanni Balcet
Mr Davide Castellani
Ms Francesca Cornaglia
Dr Rinaldo Evangelista
Prof. Alfonso Gambardella
Dr Myriam Mariani
Prof. Mario Pianta
Dr. Giulio Pierani
Ms Maria Savona
Mr Massimiliano Tancioni

University of Oslo, Norway

Prof. Rajneesh Narula

University of Reading, UK

Professor John Cantwell
Dr Simona Iammarino

3. AITEG Synthesis Conference, Universidad Complutense, Madrid SPAIN, 25-26th May 2001

The synthesis conference in Madrid, 25-26th May 2001 provided the opportunity to present an analysis of the indicators available in the AITEG database. Members of AITEG who will use the database extensively in their research attended the conference. EU scientific officers were invited and counted with the assistance of academics from some European countries not previously represented in AITEG.

The conference provided the opportunity to present an analysis of the indicators available in the AITEG database. The synthesis conference was devoted to drawing together the separate results of the studies and the methodological issues involved in such analyses. Working papers from Work Packages 3 to 5 were presented and discussed.

The research papers consisted of analyses of the impact of technology and international production on industry performances in terms of output growth and employment. These papers rely on sectoral and firm-level data and develop various statistical and econometric analyses as well as in-depth industry case studies.

List of Madrid Conference Presentations:

MARVA CORLEY AND MATIAS RAMIREZ

Innovation, Globalisation, Employment and Growth: An Integrated Database

MARVA CORLEY

Technology and economic indicators: databases and overview

- L. NASCIA AND GULIO PERANI
Patterns of Innovation in European manufacturing
- TOMMASO ANTONUCCI AND MARIO PIANTA
Innovation and jobs in Europe
- CHARLES EDQUIST, LEIF HOMMEN AND MARK SELLENTHIN
Innovation in Swedish Manufacturing: An Overview and Preliminary Analysis of Data from CIS II
- RINALDO EVANGELISTA AND MARIA SAVONA
The impact of innovation on employment and skills in services: Evidence from Italy
- M.C. PIVA, MARCO VIVARELLI
Skill bias determinants in a country with intermediate technology: the case of the Italian manufacturing sector
- S. EDWARDS AND ROBERTO SIMONETTI
The impact of technology on labour demand
- L.MIOTTI, F. SACHWALD
Patterns of R&D Cooperation by European firms: Cost-Economizing vs. Technology-Seeking
- DAVID CASTELLANI
Technological learning and exploitation of economies of scale in Italian multinationals
- A. FONFRIA, C. DIAZ, I. ALVAREZ
The role of technology and selected policies on competitiveness. A technology gap approach
- F. CASTELLACCI
Catching up and convergence in a model of technology gap and cumulative growth
- G. FELICE, F. MONTOBBIO
Technical change, non proportional growth and employment in service sectors
- HOWARD COX, SIMON MOWATT AND MARTHA PREVEZER
Work in progress on UK industry case studies using CIS data
- MATIAS RAMIREZ
Patterns and measures of globalisation: an analysis of stylized facts
- GRAZIA IETTO-GILLES
Assessing the degree of internationalization of the EU largest TNCs
- DAVID CASTELLANI AND ANTONELLO ZANFEI
Inward investments and productivity of European firms
- VINCENZO SPIEZIA
The Effect of Globalization on World Income Inequality

JOSE MOLERO AND JOOST HEYS

The differentiated impact of innovative strategies of MNCs and national firms on European systems innovation.

D. ERNST, JAN FAGERBERG AND J. HILDRUM

Cross border knowledge migration and digital information systems: theory and evidence

ALFONSO GAMBARDELLA, MYRIAM MARIANI AND SALVATORE TORRISI

How 'provincial is your region?' Effects on labour productivity and employment in Europe

ROBERTO SCHIATTARELLA AND S. ROSSETTI

International production in Italy: evidence from firms and local systems in traditional industries

GIOVANNI BALCET AND ALSO ENRIETTI

The impact of globalization in the Automotive industry: the Italian case

PAOLA CRISCUOLO AND RAJNEESH NARULA

National absorptive capacity and the stage of development

FRANCESCA BEAUSANG

Beyond the idiosyncratic: bridging less developed and developed country multinational enterprise theories

ROBERTO SIMONETTI AND MASSIMILIANO TANCIONI

A model of the impact of technology and globalisation

List of Madrid Conference Participants:

Birkbeck, University of London

Dr. Marva Corley

Ms Paola Criscuolo

Prof. Jonathan Michie

Dr Christine Oughton

Mr. Matias Ramirez

Dr Roberto Simonetti

South Bank University

Prof. Howard Cox

Ms. Linda Hesselman

Dr. Claudia Girardone

Universidad Complutense, Madrid

Prof. Jose Molero

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Mr Tommaso Antonucci
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Prof. Giovanni Balcet
Mr Davide Castellani
Ms Francesca Cornaglia
Dr Rinaldo Evangelista
Prof. Alfonso Gambardella
Dr Myriam Mariani
Prof. Mario Pianta
Dr. Giulio Perani
Ms Maria Savona
Mr Massimiliano Tancioni

University of Oslo, Norway

Prof. Rajneesh Narula

University of Reading, UK

Dr Simona Iammarino

4. AITEG Dissemination Workshop, Universita di Urbino, Urbino ITALY, 29th November- 1st December 2001

The National Dissemination Workshop was held in Urbino, Italy, 29th November 2001. Analytical research results and policy implications were presented to a broad audience of over 100 participants, which included scholars, policy makers and research students. The Universita di Urbino distributed the research papers presented at the conference at the website: <http://www.econ.uniurb.it/zanfei/convegno/convegno1.htm>

The conference received media coverage by the Italian press, which resulted in two newspaper articles written in the *Corriere Adriatico* and *Il Resto del Carlino*. Interviews with conference participants were also broadcast through the Italian radio stations. RADIO 3 MONDO interviewed Grazia Ietto-Gilles and RAI NEWS 24 interviewed Mario Pianta.

Additionally, An AITEG Project Workshop was held in Urbino, Italy 30th November – 1st December 2001. A synthesis of the evidence on the impact of innovation and globalisation encompassing the policy results of each of the research teams was presented. Additionally, there were updates on research results and smaller working groups were organized to address specific issues and projects as follows:

- Database development and integration in innovation
- Database development and integration in internationalization
- Developments of the model and integration of results
- Preparation of specific publications

There were approximately 50 participants that attended the AITEG workshop. Papers for the workshop have been disseminated through a website presenting the details of the conference at <http://www.econ.uniurb.it/zanfei/convegno/papers.htm>

List of Urbino Conference Presentations:

The following conference presentations were made at the AITEG Project Workshop in Urbino 29th November- 1st December 2001:

29th November 2001

BART VERSPAGEN, Eindhoven University of Technology
The state of innovation studies

MARIO PIANTA, Università di Urbino
Le analisi sull'innovazione in Europa

GIULIO PERANI E LEOPOLDO NASCIA, Istat, Roma
L'innovazione nell'industria

MARIA SAVONA, Università di Camerino
L'innovazione nei servizi

RINALDO EVANGELISTA, ISRDS-CNR e Università di Camerino
Gli effetti sull'occupazione

TOMMASO ANTONUCCI, Università di Urbino e Birkbeck, University of London
La distribuzione dei benefici tra salari e profitti

RAJNEESH NARULA, University of Oslo
The state of studies on multinational corporations

ANTONELLO ZANFEI, Università di Urbino
Le analisi della produzione internazionale in Europa

GRAZIA IETTO-GILLES, South Bank University, London
La globalizzazione della produzione

ROBERTO SCHIATTARELLA, Università di Camerino
L'internazionalizzazione dei distretti industriali

SIMONA IAMMARINO, Università "La Sapienza", Roma
Flussi di tecnologia e regioni

DAVIDE CASTELLANI, Università di Urbino
Gli effetti economici degli investimenti esteri

DANIELE ARCHIBUGI, Consiglio Nazionale delle Ricerche, Roma
La globalizzazione della tecnologia

30th November 2001:

MARIO PIANTA

An overview of the impact of innovation

ANTONELLO ZANFEI

An Overview of the Impact of International Production

JONATHAN MICHIE, CHRISTINE OUGHTON, MATIAS RAMIREZ, MARVA CORLEY

Innovation, Globalization, Growth and Employment: Combining the Evidence

ROBERTO SIMONETTI

Modeling the Economic and Employment Effects of Innovation and Globalization:
The Results of the Model for the UK and Italy

MARK SELLENTIN

The Impact of Innovation Policy: Empirical Results from CIS II in Sweden

ADDITIONALLY, THE FOLLOWING SHORTER UPDATES WERE PRESENTED:

LINDA HESSELMAN

New findings on innovation in the UK

RINALDO EVANGELISTA

New findings on services

RAJNEESH NARULA

New findings on multinational corporations

ROBERTO SCHIATTARELLA

New findings on the internationalization of local systems

SIMONA IAMMARINO

New findings on MNCs, technology and regions

SANTIAGO LOPEZ

New findings on innovation in TLCs in Spain

List of Urbino Conference Participants:

Birkbeck, University of London

Dr. Marva Corley

Prof. Jonathan Michie

Dr Christine Oughton

Mr. Matias Ramirez

Dr Roberto Simonetti

South Bank University

Prof. Howard Cox

Ms. Linda Hesselman
Dr. Grazia Ietto-Gillies
Ms. Marion Frenz

Universidad Complutense, Madrid
Mr. Santiago Lopez

University of Linköping, Sweden
Mr. Mark Sellenthin

Universita di Urbino, Italy
Mr Tommaso Antonucci
Prof. Daniele Archibugi
Prof. Giovanni Balcet
Mr Davide Castellani
Dr Rinaldo Evangelista
Prof. Alfonso Gambardella
Prof. Mario Pianta
Ms Maria Savona
Prof. Roberto Schiattarella
Marco Vivarelli
Antonello Zanfei

University of Oslo, Norway
Prof. Rajneesh Narula
Fulvio Castellacci

University of Reading, UK
Dr Simona Iammarino

5. AITEG Final Conference, Birkbeck, University of London, London, 19th April, 2002

The final AITEG Conference was held 19th April 2002 at Birkbeck, University of London. The conference represented the culmination of the two-year project and assessed the findings of the project and relevant policy implications for globalisation and innovation. Speakers from policy-making organisations in the UK, the media and leading academic institutions were invited and spoke on the following themes:

- Globalisation and Employment Futures
- Innovation Systems and Multinationals
- Unemployment in Europe – Policy Issues

List of London Final Conference Presentations:

PROFESSOR GRAZIA IETTO-GILLES, SOUTH BANK UNIVERSITY
Globalization and Innovation

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Annex C. List of publications resulting from the project:

- Selected papers on innovation are published in a special issue of the *International Review of Applied Economics* (vol 16, no. 3, September 2002). The Table of Contents for the issue is as follows:
 1. Michie, Oughton and Pianta, “Innovation and the Economy”
 2. Corley, Michie, and Oughton, “Technology, Growth and Employment”
 3. Castellacci, “Technology Gap and Cumulative Growth: Models and Outcomes”
 4. Castellani, “Firms’ Technological Trajectories and the Creation of Foreign Subsidiaries”
 5. Nascia and Perani, “Diversity of Innovation in Europe”
 6. Evangelista and Savona, “The Impact of Innovation and Employment in Services: Evidence from Italy”
 7. Hommen and Sellenthin, “How Innovative is Swedish Industry? A Factor and Cluster Analysis of CIS II”
 8. Antonucci and Pianta, “Employment Effects of Product and Process Innovation in Europe”
 9. Piva and Vivarelli, “The Skill Bias: Comparative Evidence and an Econometric Test”

- Selected papers on globalization are published in a special triple issue of the *Journal of Interdisciplinary Economics* (Vol 13, nos. 1, 2, 3, April 2002). The Table of Contents for the triple issue is as follows:
 1. Michie, Oughton and Zanfei, “Globalization, Growth and Employment.”
 2. Ietto-Gillies, “How International are EU Transnationals?”
 3. Castellani and Zanfei, “Sectoral Patterns of Inwards FDIs and Domestic Productivity in Europe.”
 4. Lee, “Globalisation and the Diversity of National Institutions.”
 5. Balcet and Enrietti, “The Impact of Focused Globalisation in the Italian Automotive Industry.”
 6. Cantwell, Dunning and Janne, “Evolution of Multinational Corporate Technological Systems in the UK and US.”

7. Michie, Oughton, and Ramirez, "Globalization and Economic Performance."
8. Tancioni and Simonetti, "A Macroeconometric Model for the Analysis of the Impact of Technological Change and Trade on Employment."
9. Fonfria, Guardia and Alvarez, "The Role of Technology and Competitiveness Policies"
10. Hesselman, "A Description of Responses to the UK Community Innovation Survey2."
11. Cox, Frenz and Prevezer, "Patterns of Innovation in UK Industry."
12. Moleró, "The Innovative Behaviour of MNC Subsidiaries in Uneven European Systems of Integration."
13. Michie's Book Review of Demartino

Annex D. Database Development

As detailed in the 12-month periodic report to the EU Commission an AITEG database has been constructed for the project using international indicators of globalization and innovation. The data are available at the sectoral level (in most cases ISIC Rev. 3) for the EU countries, the United States and Japan. The specific attributes of the database are detailed below:

- **Globalization:** The globalization database is collected from two sources. Firstly the OECD's Direct Investment Statistics was used to collect information on inward flows of foreign direct investment while the OECD's Globalization database was used to collect information on the activities of Foreign Affiliates in different European countries, including employment, value added and turnover. A second source of data that has been collected has come from the purchase of company databases. These include Dunn and Bradstreet's "Who Owns Whom" database that covers patterns of international ownership of companies, Thomson's Financial Database on Mergers and Acquisitions and Bureau van Dijk's Amadeus database of Performance of European companies. The data covers most West European countries and the USA over the period of the 1990s for 2 digit sectors at an ISIC Rev 3.
- **Innovation:** The Community Innovation Survey (CIS) is one of the most comparable indicators of innovative activities across the EU countries. We were unable to access the CIS data directly from Eurostat, but obtained it directly from national institutions through the initiative of each of the individual research partners. Due to the sensitivity of the data, this task took quite a bit of time and led the AITEG partners to form a consortium of institutes with the aim of sharing the information obtained from the national institutions. These data were made available to each partner only after agreeing to the terms of confidentiality: the data would only be used by research partners; and the data had to be aggregated to the appropriate level (to protect the individual firms) before each of the research partners could release it for use by the consortium.

In addition to the CIS, we have included other sectoral measures of innovation in the AITEG database. We have purchased data on R&D Expenditures from the OECD's ANBERD Database and Patenting Trends in the United States from the United States' Patent and Trademark Office. We have also obtained data on Patenting in European Countries from Eurostat's New Cronos Database.

- **Macroeconomic Indicators:** Indicators used to examine economic performance of the different countries were obtained from a number of sources both domestic and international.

Comparable employee's working hours across countries were particularly difficult to obtain due to measurement issues involved in data collection. After carefully investigating all of the possibilities we decided to use the International Labor Office's data on hours worked, supplemented with data from OECD's STAN Database and the United States' Department of Labor employment data. Data on employment, such as number of employees and compensation were also obtained from the same sources.

Output, gross fixed capital formation, exports and imports were obtained from OECD's STAN Database, with the latest data available.

We were then able to take the available data and use it to construct measures such as labor productivity, R&D and investment intensities, and capital stocks. These measures were necessary for many of the AITEG research papers.