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THE IMPACT OF INNOVATION ON EMPLOYMENT

ALTERNATIVE INTERPRETATIONS AND RESULTS OF THE ITALIAN C.I.S.

BY

Dipartimento di Economia pubblica,
Università di Roma "La Sapienza" (I)

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"The impact of Innovation on Employment in Europe. An Analysis using CIS data"

The impact of innovation on employment. Alternative interpretations and results of the Italian Community Innovation Survey

Dipartimento di Economia pubblica
Università di Roma "La Sapienza"

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Foreword

The report has been assembled by Sergio Cesaratto (Dipartimento di Economia pubblica - Università di Roma 'La Sapienza') who, in the capacity of responsible for the project, co-ordinated the research and wrote § 2.3, 2.4, 2.5, chapters 4, 5 (excl. § 5.4) and 6 (excl.§ 6.1, 6.2.1 and 6.3.1), the conclusions and the appendixes 2 and 3; Antonella Stirati (Dipartimento di Economia politica - Università di Siena) contributed very much both to the general set up and to the many revisions of the final report; she directly wrote chapter 1; § 3.1; § 5.4, and appendix 4. Sandro Mangano (Istituto nazionale di statistica - Istat, Rome) supervised the work carried out at Istat, took care of the cluster analysis and wrote § 6.1, 6.2.1 and 6.3.1 and appendix 5. Franklin Serrano (Federal University of Rio De Janeiro) contributed to the general discussion and wrote § 2.1 and 2.2 and appendix 1. Research assistantship by dott. Marco Alfò has been of considerable help. We wish to thank his patience in revising the statistical results many times. We are grateful also to Guido Pieraccini, Anna Maria Di Paolo and Nunzia Casarella for assistance at various stages of this work.

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Executive summary

Objectives of the Report

1. This Report assesses the impact of technological change on employment in Italy on the basis of the Community Innovation Survey (CIS). This evaluation is accomplished in view of more general considerations concerning the nature of technological unemployment in economic analysis and the consequent the policy prescriptions, and the possibility of assessing the overall impact of innovation from data at the enterprise level.

2. The Report starts by comparing alternative views concerning the impact of innovation on employment in the context of the explanations of the recent poor employment performance of OECD countries. The discussion attempts also to resolve a main *methodological* problem concerning the use of CIS data: (un)employment is a macro-economic issue (concerning the economy as a whole), whereas CIS data are micro-economic (concerning the individual behaviour of a number of firms). What macro-economic inferences can be safely drawn from CIS data?

Alternative interpretations of technological unemployment

3. The neoclassical and the non-orthodox approaches are examined. The neoclassical one is confident about market forces leading to full employment. It is the prevailing academic school and is currently the main reference point for most of the national and international institutions. Non-orthodox economists emphasise the importance of demand management policies.

4. Both approaches accept the idea that technical change can initially create unemployment. Divergence arise with regard to the existence of so-called 'compensation effects' for technological unemployment. These compensation effects can take place on the supply-side or on the demand-side.

'Compensation effects' on the supply-side

5. The *supply-side* is discussed first. According to neoclassical economists 'technological unemployment' does not exist in the long-run. The existence of demand functions for 'productive factors' (including labour) inversely related to their prices, characteristic of this theory, assures that a full-employment equilibrium is always realised as long as prices (including wages) are flexible. However, technological

unemployment is admitted as a short-run phenomenon due to structural imbalances in the labour market.

6. An alternative point of view, initially advanced by the Classical economist David Ricardo, regards technological unemployment, in principle, as a lasting phenomenon. Recent criticism to the theoretical and empirical foundations of neoclassical theory reinforces this point of view. The absence of automatic endogenous 'compensation effects' in the non-orthodox approach, makes it more open to the existence of compensation effects on the *demand side*.

'Compensation effects' on the demand-side

7. The existence of compensation effects on the *demand-side* has been of particular concern to non-orthodox Keynesian and Schumpeterian economics. According to the former, it is long-period aggregate demand sustained by fiscal and monetary policies that is the 'engine' of growth. According to the latter, technical change, although it can initially displace workers, positively affects gross investment, consumption patterns and, therefore, aggregate demand.

8. The Schumpeterian mechanism is not totally reliable. On the one side, product innovations can positively affect consumption, but other factors like a unequal income distribution may negatively affect it. On the other side, positive effects of innovation on gross investment are possible. None the less, they are neither a logical consequence of innovations (process innovations may be, for instance, 'capital saving' and reduce ceteris *paribus* gross investment); nor a upward trend of gross investment is to be expected by innovations. However, innovation-related investment may reduce to some extent the negative impact on gross investment of slower rates of aggregate demand.

9. It has been persuasively argued, yet, that the 'golden', full-employment years of post-war capitalism have shown a positive association between productivity growth, aggregate demand and employment. We argue that is doubtful that without policy intervention the virtuous relation between technical change, aggregate demand and employment growth would have ever been established.

Technological unemployment and the present interpretations of unemployment

10. Presently, the idea of 'technological unemployment' as a short-run phenomenon is part of the mainstream explanations of the recent poor employment performance in the industrialised countries. Structural change can create a mismatch between supply and demand of labour. For instance new skills are in short supply, whereas there is an abundance of obsolete ones. Moreover, obstacles to market forces, in particular in the

labour market, can transform a short-period disequilibrium into long-period high unemployment levels.

11. None the less, in spite of much talk of widespread and faster technological change, it is far to be clear that the recent years have seen more structural change than, say, the fifties or sixties. In addition, measures to liberalise the labour market have not delivered the promised results. The substitution of low-inflation in the place of full-employment as the main policy objective of governments, and not technical change *per se*, appears to be the main cause of the dismal employment record.

The role of the service-sector and the reduction of working-time

12. There is wide consensus regarding the importance of the service sector as a source of future jobs in industrial economies. In contrast, the manufacturing sector is not expected to supply much employment in the future. Nonetheless, the US experience indicates that manufacturing can still be an important source of jobs. In addition, many services may be object of organisational and technological reshuffling. With these *caveats*, it is nonetheless reasonable to expect the service sector to contribute more to job creation than any other sector. The expansion of the service sector does not seem to meet limits other than the ability to pay of the potential consumers. Various alternatives are illustrated, including a critique of the popular idea of developing a so-called 'third' or 'non-profit' service sector. Another popular idea is the reduction of working-time. This is a long-period process that should not be taken as a substitute, but as complementary, to more traditional full-employment policies.

The approach taken in the interpretation of CIS data

13. The fact that, according to economic theory, the impact of innovation on employment depends on specific, mainly macro-economic, circumstances suggests that much caution should be taken in drawing conclusions from the analysis of the CIS firm-based data. For instance, positive employment performance of the innovating firms might result at the cost of negative performance of non-innovating firms, so that the overall effect on the economy is uncertain. Moreover, it is not easy to separate the long-terms effects of innovations on firms' performance from the short-period effects of the business cycle. More certain are the positive effects of technical change on employment through exports. For any single country, technological advantages can sustain employment, directly by supporting output of exporting firms, and indirectly by relaxing the balance of payment constraint to national expansionary economic policies.

14. To sum up, the analysis of the employment and economic performance of innovating firms (compared to other group of firms) provide important information of

micro-economic nature, e.g. about the technological specialisation of country and the changing composition of employment. This has important implication for the macro-economic level, especially from the point of view of the international competitiveness of the manufacturing sector.

15. The Report presents a comparison of the employment and economic performance over the period 1990-1992 of three panels of firms : (i) almost 6,000 innovating firms; (ii) over 9,000 non-innovating firms, both surveyed by CIS; and (iii) over 26,000 firms covered by the 'Survey on the economic results of firms with more than 20 employees' (SERF). The latter panel contains all the firms included in CIS. SERF has been useful not only as a control group, but also because this survey integrated the information available from CIS with data on employment and other economic variables. Assuming that the business cycle affected the three groups to a similar degree, their comparison permits an evaluation of the impact of innovations on employment and other indicators of economic performance.

The employment and economic performance of the Italian innovating firms

16. Over the period 1990-92, innovating firms in aggregate perform better than non-innovating firms and SERF firms in terms of number of employees, but not in term of total hours worked and output. Various considerations lead us to believe that hours worked is a better indicator. It may be concluded that, over this period, the set of innovating firms do not show a better employment performance than the other set of non innovating firms and SERF firms. The exception are the small innovating firms that do better than any other group both in terms of number of employees and of hours worked.

17. Value added growth has also been lower in innovating firms compared to SERF firms. This mainly reflects the poor results of large firms. Small innovating firms exhibit the best performance of any group. Per-hour worked productivity growth has been higher in innovating firms. However, this outcome is associated to a poor performance in terms of output and hours worked in large firms, and to a positive one in small firms.

18. Over half of Italian exports come from innovating firms. Over the period, these have shown in aggregate higher growth rates of exports and have widened their share of total exports. Small innovating firms have shown the largest growth rates, but still play a secondary role in total exports, with small non innovating firms playing a more significant role. The positive impact of innovation on exports indicates the existence of positive, direct or indirect, effects on employment. However, regression analysis

suggests that the positive effects shown by the aggregate data may be accompanied by less systematic positive effects at firm level.

19. Investment growth by innovating firms has been higher as an average over the period, and it has reacted less negatively to the recession. This suggest that, by affecting 'autonomous investment', innovation may have softened the impact of the then forthcoming recession.

20. The share of women in the total labour force and in blue-collar workers is lower in innovating firms than in the other two groups. In addition is lower in R&D-based sectors and in large firms. There are not perceptible changes over the period. The share of white-collar workers is higher in innovating firms and, among them, higher in R&D-based sectors. The share is slightly increasing over time. It is not possible to say whether this is a cyclical phenomenon (the recession usually hits blue collars first), or a structural change. Both factors are likely to be present.

21. By combining different innovation inputs and outputs, different innovation types have been identified. Interestingly, a large degree of variety of innovative behaviour is present among small innovating firms. This approach confirmed that, in the Italian experience, the most successful types of firms are small size, and tend to focus on traditional patterns of innovation. Another explorative technique, called discriminant analysis, has been used to assess the impact of innovation variables on performance variables. It also shows that non R&D innovation sources, product innovations and small size are related to above-average employment and export outcomes.

Summary of the main findings and policy prescriptions

22. The results of Part 1 of the Report indicate that technical change can create unemployment. There are not automatic compensation effects to it neither on the supply side, nor on the demand side. In spite of this, the experience of the Golden Age suggest that, given the right set of economic policies, it is possible to associate high job creation and sustained productivity growth. Most of the new jobs can be created in the service sector, given the long-term relative decline of the manufacturing sector. However, the latter can still grow in absolute terms.

23. The results of Part 2 show that the *direct* impact of innovations on Italian innovating firms has not been beneficial to employment, with some *caveats*, however. Small firms that innovated on the basis of non-R&D sources of knowledge show encouraging results. In addition, with regard to those firms that adopted R&D-based innovation patterns, the likely cause of the dismal outcomes is not that they put too much effort on innovation, but too little. Looking at the indirect effects of innovations

on employment *via* exports and investment, the impact has likely been more beneficial. It must be noted that, as in the case of direct effects of innovation, the most traditional innovation patterns were the most successful at generating positive indirect effects on employment. Italy has had too little innovation in the high-tech. sectors, accompanied by a variety of more successful non R&D-based innovative patterns in the small firms sectors. The encouraging performance of small innovating firms is an interesting result. However, it should be taken with some caution, since these firms are a minority, although significant, of the total population of small firms.

24. To sum up, the Report suggests that on the demand side a greater job creation in Europe depends on a change in the economic policies adopted by governments. On the supply side, a problem emerges for Italy to obtain a more balanced composition of innovation patterns reinforcing her presence in the R&D-based sectors. From a European point of view, the success of the Italian small innovating firms may be of some example for developing areas within the Union.

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List of abbreviations

CIS Community Innovation Survey

IF innovating firms

NIF Non-innovating firms

SERF Survey on the economic results of firms with more than 20 employees (Indagine Istat sul Prodotto Lordo)

Introduction

Object of this Report is the impact of technological change on employment and unemployment both in theory and in practice on the basis of the results of the Italian Community Innovation Survey (CIS).

Interest in this issue at establishment and firm levels has increased in the past years. Recently, a major conference was based on papers that adopted this approach (OECD, 1995). In his conclusions, however, Prof.Zvi Griliches warned that whatever the interest of this approach at micro level, the implications at the macro-level are not certain. Griliches implicitly refers to the fact that at the enterprise level employment is not the only indicator of a good performance (since productivity growth may translate output growth in job losses). In addition, looking at the manufacturing sector, the overall performance cannot be inferred by observing a section of it, e.g. innovating firms, since, for instance, good performers may displace poor competitors. Finally, whatever the employment patterns in the manufacturing sector, much of job creation takes place, nowadays, outside it. In spite of these limitations, important policy indications can be drawn from the micro-economic level concerning, for instance, innovation and labour-market policies. However, since it is at aggregate level that the (un)employment issue is of major concern, the Report will explore the relationship between the micro-economic impact and the macro-economic consequences of technical change in order to draw some indications for the economy as a whole.

Prof. Griliches suggested that to 'better address more aggregate employment issues, it is important for future research to start exploring the interdependencies of firm behavior, examining how employment changes in one firm influence the employment in other firms' (OECD, 1995, p.11). We believe that more basic issues are at stake here than the mere input/output relationship between firms and sectors. These involve the discussion of the existence, in principle, of 'compensation effects' to technological unemployment at the micro and macro levels.

As a part of our assignment, we were asked to review the issue of technological unemployment in view of the more general concern and discussion about the poor employment performance in OECD countries and, in particular, European countries. This task fitted quite well in our research agenda since the relationship between the micro and macro aspects of the impact of innovation on employment could not be discussed without taking into account a broader sets of influences on employment level and relative policy prescriptions.

As a result, the first part of the Report sets out to provide both the necessary background for a correct use of CIS data in order to draw, along with inferences at micro-level, conclusions at aggregate level, *and* a contribution to the wider discussion on the nature of technological unemployment and on the causes and remedies of the dismal employment performance in Europe and elsewhere.

The second part of the Report investigates the impact of innovations on employment and economic performance in about 6,000 Italian innovating firms. The analysis is carried out in two stages. In the first the performance of the innovating firms is compared to that of non-innovating units and of the total population of firms. In the second stage explorative techniques is used to classify innovative behaviour of innovating firms and to compare the performance of different types of innovative behaviour. In addition, discriminant analysis is used to assess the impact of innovation related variables on the performance of innovating units.

The two parts of the Report are inter-dependent, but can be read independently from one another. The conclusions of the Report provide a synthesis of the results and policy prescriptions.

Each chapter of the Report is opened by a box that summarised its main contents and policy prescriptions. In order to make the exposition as plain as possible, some relevant material have been put in appendixes for the interested reader.

Part I

The impact of innovation on employment: review of the issues, policy prescriptions and suggestions for the interpretation of CIS data

The relation between innovation and employment is of particular interest today. It is generally recognised that the recent rate of job creation in the industrialised countries has been rather poor, particularly in Europe, and unemployment has reached in the last fifteen years or so levels unknown in the preceding post-war period. Is technological change a cause of the current disappointing rate of job creation and high unemployment levels?

This question entails a discussion of the existence of automatic, endogenous 'compensation effects' to the reduction of labour inputs per unit of output determined by technical progress.

Not surprisingly, we obtain different answer from different theories. The analytical and empirical strength of some of them are assessed here, in particular of the neoclassical approach on which the prevailing views are based, and the Schumpeterian. We will argue that the most sound view is the one in the non-orthodox tradition of Keynes, Kalecki, Kaldor and Sraffa, that we call the "Effective demand approach".

Part I is based on a distinction between those approaches that look at the effects of technical change on employment by focusing on the *supply side*, and those approaches that look at the *demand side* too.

Chapter 1 discusses the effects of technical change on the *supply* or *production side*. The neoclassical approach is discussed first. This view is the most influential nowadays among policy advisors, but it is not free of serious theoretical and empirical shortcomings. The non-orthodox view is discussed next. Conflicting policy prescriptions are compared and assessed.

Chapter 2 explores the existence of 'compensation effects' on the *demand side*. A simple model in which economic growth depends on aggregate demand is introduced. The role of innovation as a determinant of aggregate demand is discussed next. This role is then compared to that of demand management policies to establish a virtuous circle between productivity, output and employment growth.

The last two chapters draw the implications of chapters 1 and 2 both for policy and for the applied research presented in the second part. *Chapter 3* addresses current employment problems and policy implications, including a short discussion about the role of the service sector and reduction in working time in job creation. *Chapter 4* discusses the issue of the aggregate inferences that can be drawn from micro-data.

Two appendices spell out in more details on our macro-economic approach.

Chapter 1

Technological unemployment on the supply side

This chapter explores whether there are compensation effects for employment on the production side. A positive answer is provided by mainstream theory that relies on neoclassical adjustment mechanisms. The conventional interpretation of the poor employment performance of OECD countries has identified technical change as a main cause of structural maladjustment. The policy prescriptions generated by mainstream theory aim at facilitating the adjustment process by removing the institutional obstacles to it. The non-orthodox point of view recovers and develops along modern lines the Ricardian criticism to the existence of compensation effects on the supply side. In terms of policy prescriptions, the Ricardian position shares *some* of the supply side policies put forward by mainstream economists (e.g. better education and training), but does not see them as sufficient. Rather, this approach suggests the possibility of compensation effects on the demand side.

By compensation effects on the supply side is meant the existence of mechanisms on the production side which assure that, over a period of time, the workers displaced by innovations find new jobs. In this chapter 'Say's Law' is assumed, that is whatever is produced will be sold. Hence, the question is whether after an innovation market forces lead production (to which demand is by definition always adjusted) towards a full employment level. Two points of view are discussed: the mainstream and the non-orthodox.

1.1. The Mainstream point of view

The presentation of the mainstream point of view is subdivided into three parts: the basic analytical background is presented first; the recent New Growth Theory (NGT) is sketched next; finally, the connection with the mainstream interpretation of the current poor employment performance of OECD countries is specified along with the associated policy prescriptions.

1.1.1. Technical change and employment: the basic theory

According to the mainstream approach the compensation effect is essentially effected through the substitutability between factors of production, this substitutability brought about by two processes.

The first and most *direct* one is the change in the proportion in which the factors of production are used in the production process. According to the theory, the additional employment of one unit of a productive factor (say, labour), given the amount of the

other factors, will lead to output increases that are positive but progressively smaller. That is, the marginal product of labour (the additional output obtained by using one more 'dose' of labour with the given quantities of the other factors) is decreasing. Accordingly if, for example, the labour supply suddenly rises and the price of labour falls as the additional labourers compete for employment, entrepreneurs will find it more profitable to use techniques that involve a higher proportion of labour inputs in combination with the other factors, up to the point at which the marginal product of labour equals the new wage level. If the wage continues falling until there are no unemployed labourers. This will lead towards the full utilisation of the additional labour supply, albeit at a lower real wage.

The second substitution mechanism is an *indirect* one, since it works through changes in consumers' optimal choice of their consumption baskets as the relative prices of factors and goods change. Again, let us suppose an increase in labour supply and fall in the real wage. According to the theory, this brings about a fall in the relative prices of the goods that are produced with labour-intensive techniques (i.e. techniques entailing a higher proportion of labour to the other inputs). This fall tends to alter consumers' demand in such a way that the (now cheaper) labour intensive commodities will be demanded and produced in a higher proportion than they were before, thereby increasing the demand for labour in the economy. Thus, even if there is no factor substitution in production (i.e. the 'production function' has fixed coefficients), the economy will tend to full employment.

Innovations will generally cause an increase in the 'labour supply' available in the economic system, measured in 'efficiency units' (every thing else constant, the 'efficiency' or productivity of each worker is increased by the innovation). Innovations will also increase the demand for labour (as the product that can be obtained by adding units of labour - the marginal product - is now higher than the going real wage).[1] If the former effect prevails (if the innovation is 'very labour saving'), the innovation may initially create some unemployment. The competition among workers, however, will induce a fall in the real wage and the inception of the two mechanisms just illustrated.

In this analytical framework innovation has the same effect as an increase in the quantity of production factors: as these tend to be always fully employed, such an increase will necessarily result in an increase in the level of production and income 'as soon as the liberated resources can be effectively transferred to new uses'. (Hicks, 1932, p.121).

1.1.2. Endogenous technical change

A recent body of research, known as 'New growth theory' (NGT), taking inspiration from well-known results in the neoclassical tradition (Cesaratto, 1996), links the accumulation of social knowledge (either in the form of embodied technical change, or of human capital) to the 'endogenous' decision of the community to invest in R&D, design, training activities and the like (Romer, 1986; Lucas, 1988).

Consistent with the neoclassical tradition, NGT looks at economic growth as a supply side phenomenon in which saving is the 'engine' of growth. NGT reinforces this point of view by including thrift as a determinant of technical change. NGT scholars share the conventional view that innovations only create frictional unemployment 'when labor is heterogeneous and the skill composition of new hires does not necessarily match the skill composition of displaced workers' (Helpman 1992: 264).

1.1.3. Technical change and the mainstream interpretation of unemployment

While according to the mainstream view in market economies there is a continuous tendency towards the full employment of labour, it is yet admitted that some persistent unemployment will exist. The conventional explanation of persistent unemployment is based on the concept of the natural unemployment rate (sometimes also NAIRU - non accelerating inflation unemployment rate). The latter is the equilibrium unemployment rate that corresponds to the maximum level of employment attainable by the economic system, given the existence of continuously occurring changes, costs in acquiring information, and the existence of market imperfections, i.e. non competitive elements, particularly in the labour market. Equilibrium is associated to some unemployment because in any economic system 'shocks' (i.e. structural changes, including technical innovation) are continuously occurring. These are at the root of two major components of the natural unemployment rate:

i) *Mismatch between labour supply and demand*: these 'shocks' will tend to determine a difference between the characteristics (skills, education etc.) of the labour supply and those required by the employers.

ii) *Voluntary unemployment:* the 'shocks' also alter equilibrium relative prices and wages. Economic agents incur costs and take time to acquire information about these new wages, so that for each occupation there will not be a single wage offered by firms, but a distribution of wages. This, it is argued, renders rational for workers to spend some time collecting information and searching for the best opportunities while remaining unemployed (Phelps *et al.*, 1970). This type of voluntary unemployment,

other things constant, would be increased by an intensification of the 'shocks' and diminished by increasing the incentives to adjust rapidly to changes - abolishing unemployment benefits typically would have this effect.

In addition, equilibrium can be associated to unemployment due to a third factor:

iii) *obstacles to free competition and market imperfections.* Technical change may also raise the natural unemployment rate that results from this factor. 'Insiders-outsiders' models have pointed to the ability of employed workers (the 'insiders') and their unions to fix wages at a level higher than that compatible with full employment. This ability is said to derive from the bargaining advantage due to the existence of hiring and firing costs, which are to an extent determined by institutional factors (for example, the existence of costly firing procedures). The insiders' objective (according to this view) is to obtain the maximum wage compatible with preserving their employment. Hence, the marginal product of labour at the given employment level fixes a maximum to the real wage. If an initial 'shock' due to an innovation diminishes the number of jobs in some firms, the remaining 'insiders' in these firms will tend to fix the wage at the new level compatible with the lower employment. As employment diminishes, other things constant, the marginal product of labour rises[2], and so does the real wage fixed by insider workers. Were it not for the bargaining power of the insiders, the flexibility of wages would have allowed the recovery of the lost jobs in those same firms or elsewhere in the economy.

1.1.4. The mainstream policy prescriptions

The mainstream views on the impact of technical change are very influential on the national and international institutions (the main example being the influential OECD's *Jobs Study,* 1994; for the diffusion of this ideas cf. *The Economist,* February 1995). In applied research based on these views, the existence of 'frictional' problems following the introduction of innovative technologies is generally admitted. The adjustment may be slow when it entails, as it generally would do, shifts in employment from one sector to another, particularly if these involve changes in the skills required, and if these are highly specialised and difficult to acquire. In such circumstances the possibility of mismatch between the characteristics of the available unemployed labour force and those required to fill existing vacancies is high. In addition, technical change tends to increase the unemployment due to voluntary search activity and to the obstacles to free competition in the labour market.

Accordingly, attention should be focused on flexibility and individual incentives to adjust rapidly to a changing environment (e.g. OECD, 1994) in order to create an

institutional framework favourable to mobility. In this perspective the education and training/retraining systems are also very important. Policy prescriptions from NGT are consistent with this view by pointing to supply side policies devoted to sustain embodied innovation, R&D, education and the like.

To sum up, according to the mainstream interpretation, innovation and structural change may - other things constant - increase the 'natural' or equilibrium unemployment determined by mismatch, 'search', and market imperfections. The adjustment process may require time, and may be hindered by inadequate retraining opportunities or by other obstacles to the required mobility and wage flexibility. It is to the existence of various institutional rigidities - e.g. unemployment benefits or strong unions - that the disappointing employment performance should be attributed, particularly in Europe.

1.2. The non-orthodox point of view

1.2.1. The Ricardian case

At the beginning of the last century, the English classical economist David Ricardo initially maintained and later rejected the opinion, similar to the one just illustrated, that the 'application of machinery to any branch of production' is 'a general good, accompanied only with that portion of inconvenience which in most cases attends the removal of capital and labour from one employment to another' (1951, p.386). This opinion is based on the idea that an *equal* amount of labour employed with the newly invented machinery will give rise to a greater real income, beneficial to all social classes.

Eventually however Ricardo came to the different conclusion that 'the discovery and use of machinery' *could* be 'injurious to the labouring class' (1951, p.390). To appreciate Ricardo's argument, think of labour as a generic input, part of the circulating capital. Suppose that the introduction of an innovation allows the production of the same or even greater amount of social income by using half of the input. The use of the input is correspondingly reduced. If that input is labour, there is technological unemployment[3]. Observe that Ricardo did not rely on wage flexibility and 'factor substitution', a mechanism later introduced by neoclassical economists, as a compensation effect[4].

The interest and the force of the 'Ricardian case' has been renewed by the recovery of the Classical approach by Sraffa (1951) who noted the absence in the classical approach of the substitution mechanisms later envisaged by the neoclassical economists. It is the absence of these substitution mechanisms that explains the possibility of persistent unemployment in the Ricardian framework (for a formal demonstration of this

proposition see Montani, 1985). Failure to perceive this crucial difference has often led to misinterpretations of the 'Ricardian effect' as a 'transitory' or 'short run' phenomenon occurring in the transition towards a new, full employment equilibrium and, similarly, to associate it to particular assumptions concerning the nature of technical progress (Wicksell, 1981 [1924], Schumpeter, 1954; Katsoulacos, 1986).

In addition, Sraffa suggested that not only the neoclassical substitution mechanisms were absent in the classical approach, but that their later introduction was flawed by *logical* inconsistencies. This inspired in the 60s what has probably became the most famous controversy in economic analysis, that on the neoclassical notion of 'capital' (Harcourt, 1972; for more recent discussions see Eatwell et al., 1990; Kurz, Salvadori, 1995, Ch. 14).

1.2.2. Logical inconsistency of neoclassical theory

Put simply, this controversy pointed to the peculiar nature of the 'capital', that it is not an 'original' factor measurable in some conventional unit, as is the case for labour or land, but it is a produced commodity measurable only in 'value'. This has important consequences for the reliability of the two neoclassical substitution mechanisms envisaged in § 1.1.1.

The first substitution mechanism - *direct substitution* in production - predicts that when, for example, the wage rate falls, methods of production using more labour relative to the other inputs will become more profitable. Sraffa (1960) and other contributors to the capital controversy of the 60s have shown that this is not the general case, and that when there are a multiplicity of techniques and 'heterogeneous' capital goods (that is many kinds of capital goods), the so-called 're-switching of techniques' makes the neoclassical prediction unreliable: when the wage rate falls *less* labour intensive techniques may become profitable. This is because as distribution varies the relative prices of the produced capital goods used directly and indirectly in the production of any commodity will change. Thus it may happen that the *same* technique - using directly and indirectly a certain amount of labour per unit of net output - is the most profitable (least costly) for low levels of the real wage rate as well as for high levels of it, while a different technique is the most profitable at 'intermediate' levels of the wage rate (Garegnani, 1970).

The second mechanism, *indirect substitution* through changes in consumption patterns, requires a) that as, for example, the wage rate declines, the relative price of the labour-intensive goods falls; b) that this is followed by a larger consumption of the relatively cheapest goods. Now the first step is put in doubt again by the conclusions of the

Capital theory controversy. It has been shown (Sraffa, 1960) that as the wage rate diminishes, the relative price of any commodity may alternately fall and rise, so that no *a priori* expectations as to the direction of the change is justified. The second step (b), on the other hand, is not certain, as income effects (i.e. changes in individual income levels determined by the change in distribution and prices) may alter demand patterns in such a way as to offset the effects of substitution in consumers' choices. Results obtained in general equilibrium theory show that, even with the usual neoclassical assumptions on individual consumers' behaviour, it cannot be proved that the aggregate excess demand functions for goods are a decreasing function of their prices (Kirman 1989).

It can just be added that the empirical results concerning demand curves for factors of production, particularly labour, do not appear very robust (Anyadike-Danes, Godley, 1989; Zenezini, 1993; Card, Krueger 1996).

1.3. Policy implications

To those trained in neoclassical economics, the "Ricardian approach" may at first sight appear as too primitive, and missing important aspects of consumers' and entrepreneurs' behaviour. We have shown, however, that neoclassical substitution mechanisms require assumptions concerning the direction of the substitution taking place when relative prices and distribution change, which are undermined by theoretical results. Nor can it be claimed that, to counter the theoretical difficulties, there are strikingly supportive empirical results.

Accordingly, the modern non-orthodox theory confirms Ricardo's opinion that there are no *necessary* compensation effects to technological unemployment. *Some* of the supply-side policies proposed by mainstream economists, especially those concerning education and R&D, are useful in themselves, but should not be relied upon as the only way to reach full employment. Other measures, leading to undermine labour bargaining power, may make the situation worse (not only in terms of social justice), by weakening the demand for consumption goods, as shown in the next chapter.

While the role of compensation effects on the demand side is ruled out in principle by neoclassical theory (since in this view substitution mechanisms always lead the system towards the level and composition of output that ensures the maximum possible utilisation of all the existing resources), the Ricardian approach is not *necessarily* associated to the acceptance of Say's law, and once this is rejected, the analysis is open to the investigation of the compensation effects and policy prescriptions on the demand side.

Footnotes

[1] The negatively sloped labour demand schedule which represents the employment level chosen by the employers at different real wages coincides with the marginal product of labour at different employment levels (see text above) . An increase in the quantity of the other factor of production (say,' capital') to which labour is applied will shift this schedule outwards (the marginal product obtained by the same quantity of labour will be higher if labour is used in association with a greater quantity of 'capital'). Innovations generally will increase the supply in 'efficiency units' of both factors ('capital' and labour in our example). The increase in the supply of land will shift outwards the demand schedule for labour, thus raising labour demand at the given wage level, but will also increase labour supply in efficiency units. If the latter effect prevails the real wage rate compatible with full employment will have to fall. The case of a 'labour-saving' innovation was first isolated by the English economist John Hicks [1932].In this case the effect of technical change is such that in equilibrium (i.e. when all factors are fully employed) even if the marginal product of both labour and capital are increased, the latter is so in a greater proportion. Hicks called "very labour saving" the innovations leading to a fall in the full employment equilibrium real wage.

[2] According to neoclassical theory, given the capital stock, a decrease in the amount of employed labour would raise the marginal product of labour (i. e. the product obtained by the last unit of labour employed with the given capital)

[3] In addition, if the innovation is such that part of the circulating capital is substituted for by fixed capital, the level of *total* production - i.e. inclusive of intermediate goods - will be reduced, thus also causing unemployment. If the input is labour, it is the production of consumption goods that is reduced (the Classical economists regarded subsistence goods as part of circulating capital). In other words, the introduction in any industry of a new technique leading, if there is competition, to a fall in production prices, will entail the disappearance of that part of the social income that derived from the production of the commodity with the old method (Garegnani, 1962, p. 98).

[4] Ricardo, that shared Say's law, conceded that the negative effect of the innovation on employment *could* be gradually offset if the capitalists invested their higher real incomes, thus enlarging productive capacity and employment.

Chapter 2

Technological unemployment on the demand side

The chapter maintains that long-period output depends on growth of Effective demand. It is claimed that the "autonomous components" of aggregate demand determine the long-run trend of Effective demand. The autonomous components include "autonomous investment" induced by technical change. The positive link between innovation and autonomous investment advocated by Schumpeterian economists is examined. The positive association between output and productivity growth underlined by the 'Regulation approach' is also illustrated. The conclusions is that although innovation (especially product innovations) can positively affect investment and employment, this is not granted. More certain are the positive effects of innovation on a country's export performance. The economic policies oriented towards full employment are the major explanation of the virtuous circle between productivity and output growth during the first post-war decades.

2.1. Technological change and Effective demand

According to the mainstream view the main explanation for economic growth lies in the saving propensity of the community in so far as a higher saving rate would allow the production of more investment goods that increase the capital stock. In his major work, the *General Theory* published in 1936, the British economist J.M.Keynes challenged this view by showing that since productive capacity is generally not fully utilised, within the limit of the full utilisation of the existing capital stock a larger amount of investment does not require a prior saving decision. On the opposite, the income generated by the fuller utilisation of capacity would generate an amount of saving equal to the investment decisions.

Mainstream economists circumscribed this criticism to short-period situations of low business and financial confidence arguing, however, that in those circumstances active fiscal and monetary policies were necessary to reach full employment. This was the conventional wisdom shared by the national and international institutions until, in the late sixties, the Monetarist revolution begun to re-establish the pre-Keynesian doctrines as the prevailing view. Although the Monetarist revolution has subsequently receded, the currently prevailing mainstream approach still reflects pre-Keynesian views.

More faithful followers of Keynes have tried the opposite road of extending his analysis to the *long-period* claiming that also in the long-run (when the productive capacity can vary) investment is independent from the saving supply. Investment would depend instead on long-period expected aggregate demand. Accordingly, long-period productive capacity and, given the technology, long-period employment also depend on

the long-period level of effective demand[1]. Innovations affect the labour requirements per unit of output and may negatively affect the employment associated with any level of output. However, high growth rates can, in principle, compensate decreasing labour requirements[2]. Does innovation compensate technological unemployment by positively affecting effective demand? To answer this question we shall sketch a simple verbal model of the determination of the level of long-period aggregate demand in order to single out with some precision where technical change matters (for additional details cf. Serrano 1995, 1996 and *appendix 1*).

2.2. An Effective demand approach to the determination of long-period output

In a long-period Keynesian approach productive capacity tends to adjust to long-period effective demand through gross investment. The components of effective demand can be split in two groups, *induced* and *autonomous* according to whether they depend on *expected* aggregate demand.

Induced components of Effective demand

Induced consumption mainly derives from 'contractual incomes', principally wages and salaries, whose amount is determined after production decisions have been taken by entrepreneurs on the basis of expected demand. Hence, induced consumption cannot determine the pattern of Effective demand since is generated by it.

Gross investment is actually divided in two components[3]: *induced* and *autonomous*. The first component, induced capacity-generating investment, includes all purchases of produced means of production that can have capacity-generating effects in the sense that they necessarily add to the potential supply of gross output of the economy. These expenditures are to be considered induced precisely because of the fact they have capacity-generating effects and hence will tend to be carried out only if the overall expected expansion of aggregate demand justifies them. Induced investment, therefore, cannot be taken as a long-period determinant of Effective demand unless we reason in circle. *Autonomous investment* will be considered below as part of autonomous expenditure.

Autonomous components of Effective demand

Autonomous expenditure (or 'Final demand', Garegnani, 1962) is neither generated by the expected levels of aggregate demand, since it does not by definition create productive capacity, nor depends in principle on 'earned incomes'. Autonomous

expenditure thus comprises all the sources of potential discretionary or autonomous injections of purchasing power in the economy. It includes:

(a) Total *government spending*, whose level is autonomously decided by Government and whose multiplying effects *generate* the amount of taxation and saving necessary to finance it[4];

(b) Total *exports* whose level depends, *ceteris paribus,* on foreign demand.

(c) *Autonomous consumption*, financed by consumers' credit and demobilisation of wealth

(d) *Autonomous business expenditures,* including R&D or managerial expenses, that do not depend on, nor directly lead, to capacity creation; and *autonomous investment*, that is that part of gross investment not induced by expected demand but by *technical change*.

The level and rates of growth of the autonomous components of aggregate demand explain the levels of induced consumption and induced investment. Effective demand, which is the sum of the autonomous and induced components of aggregate demand, would in turn explain the long period level of output (and capacity) and, given the technology, the employment level (Kaldor, 1970; Kalecki, 1971; Garegnani, 1962, 1992; Serrano, 1995, 1996)[5]. Fig.6.1 shows the working of the model.

Let us now find out where technical change matters and can generate a compensation effect on the demand side.

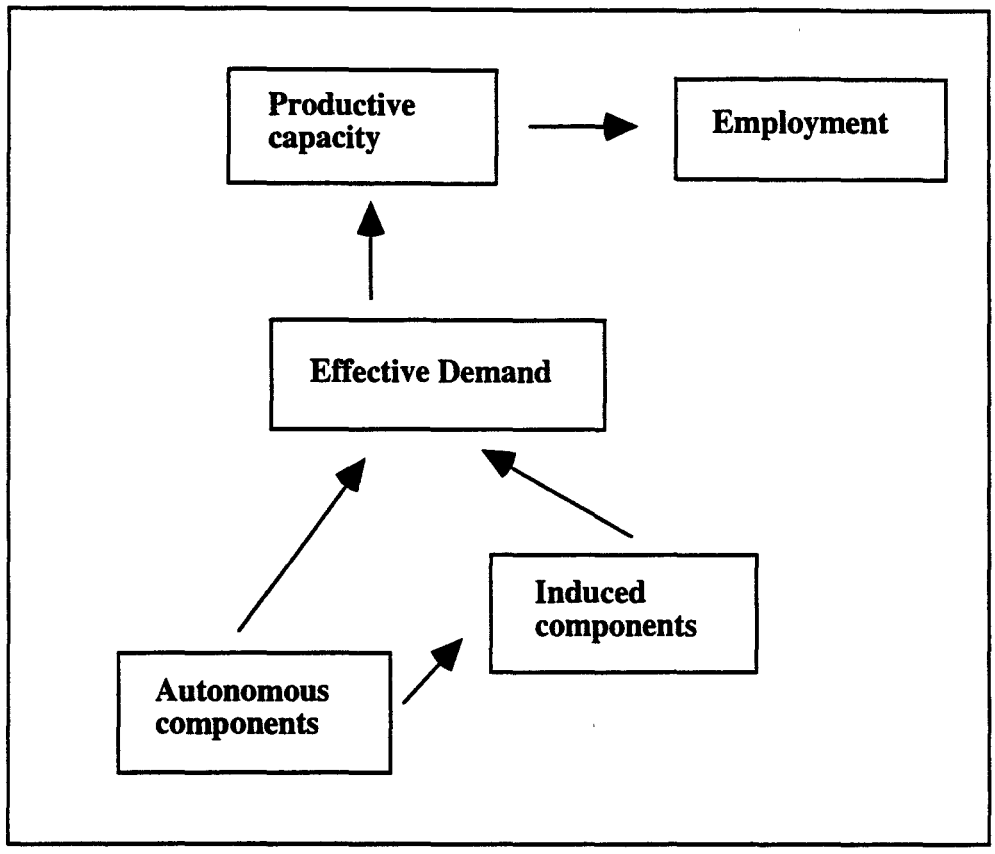
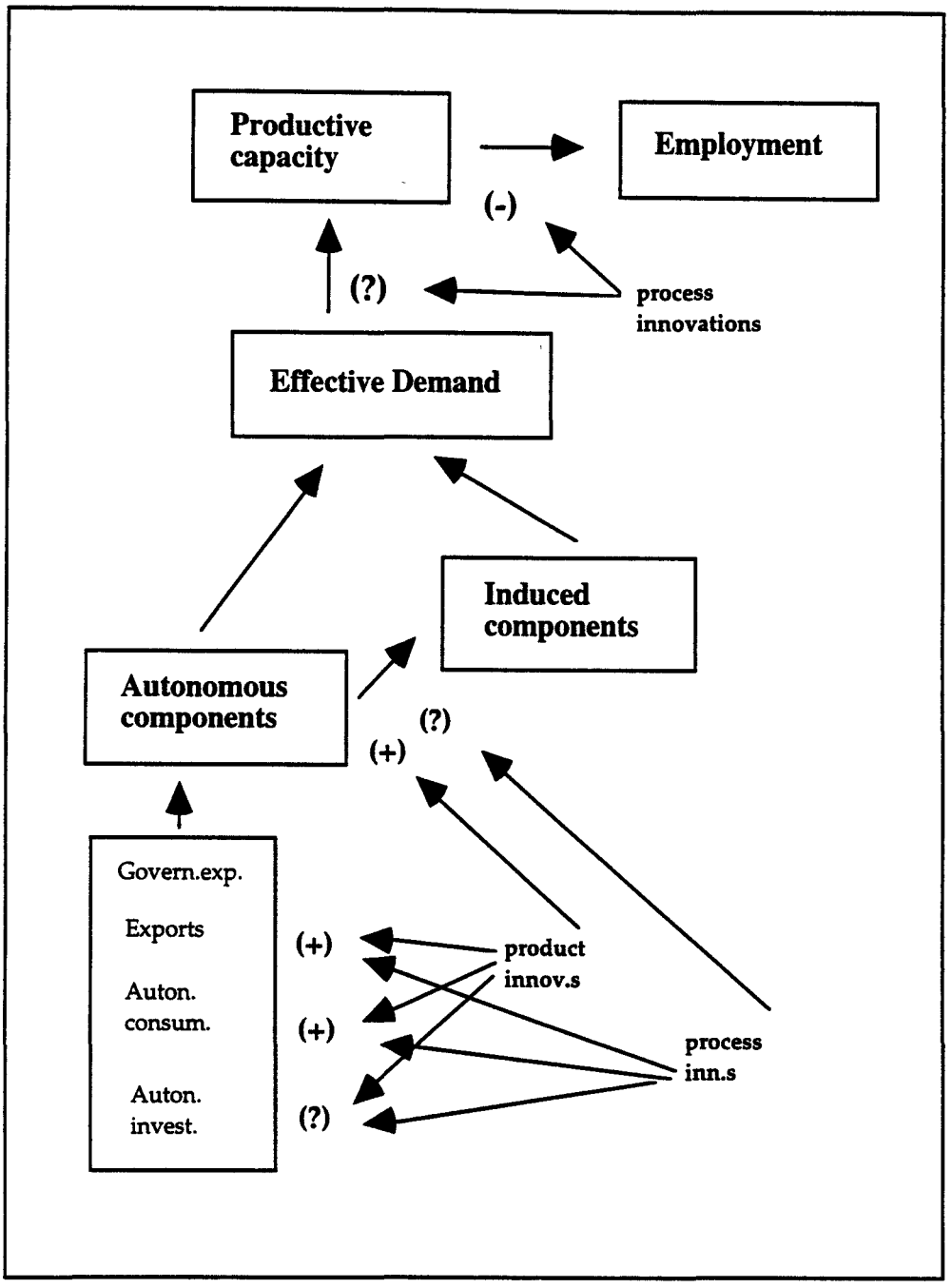


Fig.6.1 - A simple Keynesian long-period model

2.3. Technical change and the autonomous components of effective demand

Technical change can affect Effective demand (a) *via* its effects on the aggregate marginal propensity to consume (which tells us how much induced consumption will be generated by a given level of Final demand); (b) by affecting the aggregate capital-output (acceleration) ratio (which tells us how much gross investment will be induced by expected aggregate demand) and (c) through its effects on the growth of the autonomous expenditure (which is the final 'engine' of growth). Fig.6.2 pictures the macro-economic effects of innovations.



legenda:+ positive effect; - negative effect; ? uncertain effect

Fig.6.2 - The effects of product and process innovations in the long-period Keynesian model

Let us consider them in order.

(a) In what regards *induced consumption, product innovations* may play the positive effect of keeping, by continuously creating new needs and by making consumer durables obsolete, the marginal propensity to consume out of 'contractual incomes' at high levels[6]. On the other hand, *process innovations*, which invariably tend to increase labour productivity and displace workers can

(and in the European context probably do) shift distribution away from wage-income, something that depresses the aggregate marginal propensity to consume (see Arestis, Howells, 1995). Income distribution is, therefore, an important determinant of the final effects of innovations. For instance, if real wages increase with productivity, the fall of production prices that follow process innovations is quite substantial, mass consumption of previously inaccessible products and services might become possible, thus increasing the marginal propensity to consume (Garegnani, 1962, p.98). The negative effects of process innovations are thus compensated by a larger consumption of the now cheaper commodities.

(b) Different forms of technical progress may affect the capital-output ratio in various ways. If technical change is neutral[7] it will neither stimulate nor reduce induced investment. If it is capital-saving it will *ceteris paribus* clearly reduce investment. Only if technical change is capital-using will it increase the capital-output ratio and hence stimulate induced investment[8].

(c) Innovation can have positive effects on *autonomous expenditure. Product innovations* can foster *autonomous consumption* both of the working classes (the more, the more income distribution and consumers credit are favourable to mass consumption) and of the wealthier classes (that can use their financial wealth to have access to new products[9]). Various theories and experience suggest that technological advantages are a main determinant of *export* performance. Other factors, including the foreign exchange rate policy, can of course affect the establishment of a virtuous circle between export performance and productivity growth (Kaldor, 1970). Technological advantages reduce also import penetration. Relaxing the balance of payment (or foreign) constraint allows, in turn, more expansionary domestic economic policies (McCombie, Thirwall, 1994). *Autonomous business expenditure* such as R&D may have a positive linkage with the national technological patterns (more or less R&D oriented, see Cesaratto, Mangano, 1993) and the expectations of profitable results from R&D. Finally, technological competition has been traditionally seen as a main determinant of *autonomous investment.*

The effects of innovation on induced and autonomous consumption and autonomous investment are seen by economists of different persuasions (including Schumpeterian, Keynesian, but also, as their last resort, neoclassical economists) as the major way through which a compensation effect on the demand side can reveal itself. [10]

We agree that product innovations may generate positive effects on consumption and, by this way on induced investment, given a suitable income distribution and the

availability of cheap consumers credit. A discussion of the relationship between innovation and autonomous investment, that we name after his most famous proponent the 'Schumpeterian thesis', is presented in *appendix 2*. There we conclude that the existence of positive compensation effects to technological unemployment on the demand side through (autonomous) gross investment is a *possible* but not a *necessary* result. Empirically, however, a positive association between productivity and demand growth (so that employment was not badly affected by technical change) can be found in the so-called years of 'golden age' of post-war capitalistic economies. If the 'Schumpeterian thesis' does not provide a satisfactory account of the association, how can we explain it?

2.4. The association between productivity and demand growth and the role of policy intervention

Table 2.1 shows a clear association between productivity (i.e. technical change) and output (i.e. demand) growth for the industrial sector. The association of high demand and productivity growth in the first period produced a positive employment growth rate (0.37%); whereas the association of low demand and productivity growth in the second period resulted in a negative employment growth rate (-0.64%). The mere existence of this correlation shows that a high rate of technical change may be associated with high income growth and full employment (and *vice versa*). The association between output and productivity growth has been particularly emphasised by a group of Anglo-French economists, named 'Regulationists'[11]. The Regulation school explains the virtuous circle through the institutional context favourable to workers' consumption. However, whereas the 'wage-led regime' can have had positive effects with respect to product innovations, it cannot have been enough according to our view.

By increasing the marginal propensity to consume, a 'wage-led regime' magnifies the effects on the level of capacity generated by a given level of the autonomous expenditure. It cannot, however, explain how autonomous expenditure is generated. We believe that two forces were behind the high rate of growth of autonomous expenditure in the fifties and sixties: government expenditure and export growth (see below § 3.1).[12]

We reach therefore the conclusion that whereas technical change may be positively associated to economic growth, it is doubtful that without the *expansionary national and international policy set-up* that marked the post-war period (including high military spending [Pivetti, 1992]) this sort of virtuous circle would have ever been established[13].

2.5. Policy implications

The association of high productivity growth with near-full-employment during the first post-WW II decades shows that technical change is not necessarily linked to technological unemployment.

It can be argued, however, that this has not happened because (or at least not exclusively because) of *compensation effects* to technological unemployment on the *demand side*. The effects of *process* and *product* innovations *on gross investment* cannot, however, be taken for granted, although those of *product* innovations *on consumption* patterns are generally more favourable (given suitable income distribution). From the experience of the 'golden age' we draw the conclusion that the pursuit of full-employment policy requires suitable national and international economic policies to be adopted. These are policies favourable to autonomous demand growth through government expenditure and exports, along with income policies favourable to mass consumption.

For each single country, however, there is one case in which the national innovation capabilities may have positively affected the trend of a specific autonomous component of demand. This is the case of *exports*. Although affected by other circumstances, such as foreign exchange rate policy and international macro-policies, technological advantages are a main determinant of each single country's export performance. Exports may also favour national reflationary policies by relaxing the foreign trade constraint. Germany and Japan are, of course, the countries with the greater evidence for the impact of innovations on exports and growth.

Tab. 3.1 - Value added, productivity and employment in the industrial sector. Annual rates of growth. Selected Oecd countries. 1960-1990.

	Value added	Productivity	Employment
1960-1975			
USA	3.79	2.54	1.25
CAN	5.03	2.58	2.45
JPN	7.96	6.25	1.71
B	4.91	5.27	-0.36
FR	3.90	3.42	0.48
WGR	3.21	4.39	-1.18
ITA	4.90	4.75	0.15
NL	5.35	6.50	-1.15
UK	0.39	1.83	-1.44
1976-1990			
USA	2.83	1.93	0.90
CAN	2.20	1.30	0.90
JPN	5.52	4.85	0.57
B	1.47	4.38	-2.91
FR	1.15	2.90	-1.75
WGR	1.54	1.80	-0.26
ITA	2.99	3.75	-0.76
NL	0.73	1.06	-0.33
UK	1.81	3.69	-1.88
1960-1975	4.42	4.05	0.37
1976-1990	2.19	2.83	-0.64

Source: Pini 1994

Footnotes

[1] Since no automatic tendency of aggregate demand to adjust to productive capacity is envisaged, the 'Effective' level of aggregate demand will in general be different from the 'Notional' or 'Potential' level corresponding to the full utilisation of capacity. Effective demand is analytically defined as the amount of aggregate output demanded at normal prices (see appendix 2).

[2] As shown by the identity-equation
$e = y - p$,
where, respectively, the symbols are the growth rate of employment, of total income and of productivity.

[3] Gross investment includes the replacement of obsolete capital goods and net additions to productive capacity. Obsolescence can be physical and economic. Economic obsolescence is caused mainly by technical change.

[4] *Government spending* does not, therefore, absorb saving otherwise devoted to investment, as generally maintained by mainstream economics (for recent contributions: Pressman, 1995; Symposium on the *Journal of Postkeynesian Economics*, 1994-95).

[5] It is important to observe that the employment creation power of each of the autonomous components of aggregate demand is not the same, and some disaggregate analysis would be in order here. To give an example, Government expenditure on social services or public works has a *direct* impact on job creation, in addition to the *indirect* one due to the multiplicative effects on induced investment and consumption. Similarly, a rise in visible exports increases the demand for manufacturing goods and also sets out a multiplicative effect. However, the increase of demand for manufacturing good might have a smaller direct impact on employment given the lower elasticity of employment with respect to output in this sector. This has been the Italian experience in the recent export-led growth that has brought about little job creation. Also the composition of induced consumption and induced investment matters. The general opinion is that the larger the share of induced demand for services, the greater the number of jobs generated by the expansion (see § 3.2.2). The service sector is, of course, quite heterogeneous, and the employment elasticity to output is not the same everywhere

[6] *Income distribution* is particularly relevant for the impact of product innovation on consumption patterns. The Anglo-French *Règulation school* (e.g. Boyer, 1988) sees in the institutional contest favourable to the translation of productivity growth in higher real wages and growing consumption patterns a key factor in the generation of a virtuous circle between productivity and output growth in the post-war period (what they call "wage-led regime"). Low interest rates may have also favoured consumers' credit. On the other hand an income distribution favourable to high-incomes, high interest rates, high rents etc. may favour the diffusion of new luxurious consumers' goods. The marginal propensity to consume of the wealthiest, however, would remain lower than that of low and middle income classes.

[7] An innovation that does not affect the capital/output ratio is generally called 'Harrod neutral'.

[8] In the context of the European economy in the period over consideration it seems unlikely that technical change has had a clear capital-using bias (although we cannot be sure if it has been capital-saving or neutral). Therefore it is unlikely that induced investment has been stimulated in this way by technical progress but at the same time it is not clear that it has been affected negatively. According to the first Italian innovation survey for the period 1981-85, 65% of firms declared that innovation implied a higher use of fixed capital, and only 4% a lower use. It is not clear, however, if this is true in value terms. The efficiency of computer based machinery has increased dramatically, but at the same time their price has fallen. Better trained and more disciplined work-force may also have led to economies in investment expenditure through a more efficient exploitation of plants (Marsh, 1996).

[9] In this regard, Lance Taylor quotes approvingly Pasinetti: 'Household happily dissave to switch to innovative products as they appear - how many staples of the 1990 advanced economy consumption baskets (VCR's, Fax machines, shopping centres, sushi bars) even existed ten years before? As Pasinetti (1981) emphasises the genius of capitalism resides in forestalling an unemployment crisis by inventing new products to replace old ones as demand for them subsides' (Taylor, 1991, p.15).

[10] The Schumpeterian view has been recently summarised by Prof. Chris Freeman: 'Whereas in neo-classical theory the emphasis is on factor price flexibility and in keynesian theory on aggregate demand, with Schumpeter it is on autonomous investment, embodying new technical innovation which is the basis of economic development and new employment. In such framework economic growth must be viewed primarily as a process of reallocation of resources between industries and firms. That process necessarily leads to structural changes and disequilibrium if only because of the uneven rate of technical change between different industries and countries. Economic growth is not merely *accompanied* by fast growing new industries and the expansion of such industries; it primarily *depends* on that expansion. The new firms and new industries are an essential source of the new employment which compensates for the loss of jobs in declining industries and firms. It is a process of 'creative destruction' in which the process of job creation outstrips that of job destruction as a result of profound structural adjustment and not as a smooth incremental process' (Freeman, 1995, p.52). The subsequent passage shows how the OECD editors of the journal can easily embody Freeman's view in the mainstream ones: 'In general, economists have taken the view that technology (...) may cause local and temporary unemployment, but it also causes demand to grow. If demand growth offsets productivity growth, and if wages are flexible downwards, then unemployment will not be a problem; within this type of approach, therefore, there is no general problem of unemployment as a result of technological change' (*STI-Review*, 1995, Introduction, p.11)

[11] Taking inspiration from Kaldor they argue that a virtuous circle (or "cumulative causation") was then established between:
(a) a positive relationship *from* aggregate demand growth *to* productivity growth ("productivity regime"), accompanied in turn by
(b) a positive relationship *from* productivity growth *to* aggregate demand growth ("demand regime").
Increasing returns, based on the so-called 'Fordist model', and technical change would explain (a). The institutional set up favouring the translation of higher productivity in higher wages and consumption, and/or in more competitive exports would explain (b). See Petit (1995, p.21): 'productivity and demand are linked...by a set of agreements or institutional arrangements tying elements of production organisation to elements of the formation of demand'.

[12] Note that we talk of government expenditure and not of government budget deficits. Keynesian policies are often confused with big deficits. As shown in simple terms by the well known 'Haavelmo theorem', an increase in government expenditure does not imply more internal deficit.

[13] Regulationists provide various explanations why the post-war 'accumulation regime' broke. The most characteristic, and least clear, refers to the 'breakdown of the Fordist model of production' when the well-known Kaldor-Verdoon law ceased to operate (e.g. Boyer, 1988, p.240). Others have seen the cause of lower accumulation in the 'profit squeeze' caused by prolonged low unemployment rates and workers' high bargaining power in the 60s (Marglin, Schor, eds., 1990; see Petri, 1994). Interestingly enough, an econometric test run for 9 OECD countries has concluded that whereas the elasticity of productivity to demand has not changed significantly in recent years, it is demand that has ceased to match productivity gains (Pini, 1994). The deflationary macro-environment and the institutional set-up more favourable to profits would be the main explanation. From a more conventional theoretical perspective, also Svi Griliches attributes to deflationary policies the productivity slow down in the US (Griliches, 1988).

Chapter 3

Empirical evidence and policy prescriptions

This chapter draws together the threads of the discussion to address the question of whether current problems of poor job creation are due to technical innovations. The policy implications of the conflicting views are compared. The evidence does not lend much support to the mainstream view of the effectiveness of labour market reforms. By contrast, macro-economic policies can be effective in curing high structural unemployment by sustaining final demand and investments. Increases in demand and employment are to be expected mainly in the service sector, provided conditions allow potential consumers to afford the (costly) services they need. Reductions in working time may contribute to increasing the number of jobs, but do not represent an alternative strategy to expansionary macro-economic policies.

The main conclusion of the previous chapters is that technical progress may cause persistent unemployment as there are no *necessary* endogenous 'compensation effects' either on the supply or demand side. Innovations, however, are not necessarily to blame since suitable economic policies can well compensate the negative effects of innovations, allowing their positive effects to increase the social welfare.

An opposite view is held by mainstream economists, according to whom the market spontaneously brings about compensation effects on the supply side. Nonetheless, even in the mainstream view technical change may lead to unemployment as it may cause a temporary mismatch between demand and supply, raises that voluntary unemployment related to the search for the best opportunities, and finally may increase the unemployment related to the existence of various obstacles to the free operation of market forces.

This chapter will look at some evidence to assess these conflicting thesis.

3.1. Assessing the different interpretations

The opening remark of the most recent influential institutional document on employment summarised its main conclusion, reflecting its mainstream views on the causes of unemployment:

> After having considered the available evidence and the various theories which have been advanced to explain today's unemployment, the basic conclusion was reached that it is an inability of OECD economies and societies to adapt rapidly

> and innovatively to a world of rapid structural change that is the principal cause of high and persistent unemployment. (OECD's *Jobs Study,* 1994, p.vii).

Various stylised facts, some of which were presented in that same Report, seem to disprove this view.

First, comparison between the post-war phase of rapid economic growth and near full-employment and the subsequent phase of high unemployment and slower growth shows that the change of 'regime' cannot be easily attributed to an intensification of innovation and structural change. The evidence shown in chapter 2 suggests that productivity has increased much less in 1970s and 1980s than in the 1960s (see also table 3.1). In addition, the analysis of other indicators measuring the changes in the employment share of different sectors of production also shows that structural change has been less intense in the recent phase. This leads the OECD's *Jobs Study* to conclude that: 'virtually in all countries, turbulence in employment shares by sector during the 1980s either decreased or was stable compared to the 1970s. In the majority of countries for which data are available, industry shifts in employment during the 1980s were also much smaller than during the 1960s' (OECD, 1994, p. 16).

Secondly, flexibility and competition in the labour market have increased since the late 1970s, due to the policies followed in most industrialised countries (see also OECD, 1994, pp 9; 19).[1] The two most active European countries in this direction, Spain and the UK, have not shown a good employment performance (Michie, Wilkinson, 1995). Although 'labour market flexibility' and low wages might have stimulated employment in specific service sectors (by lowering the price of these services) or attracted foreign investment, little empirical evidence (let alone analytical proofs) has been provided as yet as to the effectiveness of these measures to support the growth of modern sectors.

Tab. 3.1 - Output, employment, productivity and labour force growth. 1960-90. Annualised percentage rates of change.

	GDP*			Employment		
	1960s	1970s	1980s	1960s	1970s	1980s
North America	4.4	2.8	2.6	2	2.3	1.7
EC	4.8	3.3	2.1	0.2	0.4	0.5
OECD	5.1	3.3	2.7	1	1.2	1.1

	Productivity			Labour force		
	1960s	1970s	1980s	1960s	1970s	1980s
North America	2.3	0.5	O.8	1.8	2.6	1.7
EC	4.6	2.9	1.7	0.2	0.7	0.8
OECD	4	2.1	1.5	0.9	1.4	1.2

* Gross Domestic Product at 1985 prices and exchange rates.

Source: Oecd, 1994, tab.2.1.

The fact that employment growth has been higher in the US than in Europe is very often invoked as an argument in support of the mainstream view that labour market flexibility favours job creation. However, other structural factors may explain the lower impact of income growth on employment in Europe compared with the US. In Europe the manufacturing sector, in which productivity growth is the fastest, has a larger share in output than in the US. In addition, Europe has constantly had higher rates of productivity growth in all sectors, and in particular in manufacturing (table 3.2). This was the case also in the sixties, when unemployment was higher in the US than in Europe. This suggests that the explanation may not lie in the alleged greater flexibility of the US labour market. A different explanation may be found in the persisting large productivity gap between Europe and the US (table 3.3). This gap indicates that while in the US technology is close to the 'frontier' of existing possibilities, and productivity gains may only be obtained through innovation, including organisational innovations at firm or industry level, in Europe technology is often backward, hence the pace of productivity growth is not limited by the availability of new, improved technologies, as large gains may be obtained simply by moving towards the already existing 'frontier' of technological and organisational possibilities. The conclusion is that Europe needs much higher rates of income growth than the US to bring about the same job creation, the opposite of what has happened in recent years: between 1960 and 1970 income grew over 10 points more in Europe than in the US, but at similar percentages in the two later decades (table 3.4).

The lack of evidence in support of an intensification of structural change or effectiveness of labour market reforms disproves the mainstream interpretation. Yet this view continues to be the background for the policy prescriptions by academic and official institutions[2].

In addition to the main conventional view, two other popular opinions should be recalled here. Albeit not necessarily stemming from the mainstream, neoclassical approach, they both attribute current high unemployment rates to factors other than the deflationary policies pursued in the last decades and the slow growth of the autonomous components of demand.

Tab. 3.2 - Sectoral annualised growth rates of productivity. Europe and US. 1960-1990.

	1960 -68		1973 -79		1979 -90	
	Europe	US	Europe	US	Europe	US
GDP/empl.s agricolture	5.3	3.6	4.3	1.1	3	5
GDP/empl.s industry	4.6	2.5	2.4	-0.1	2.3	1.4
GDP/empl.s services	2.9	2.3	1.5	0.2	0.6	0.4
GDP/empl.s total	4.4	2.6	2.1	0.2	3	1

Source: Oecd, Historical Statistics, 1960-1990.

Tab. 3.3 - Sectoral per-capita GDP in Europe and US. Various years. (million of US$ at 1985 prices and exchange rates)

	1960	1968	1980	1987
		EUROPE		
Agricolture	3.22	4.47	5.94	6.07
Industry	9.96	13.44	18.58	21.11
Services	12.36	15.89	20.61	22.17
		UNITED STATES		
Agricolture	13.32	18.25	26.26	24.96
Industry	32.25	36.04	39.50	40.66
Services	28.24	35.48	34.73	37.16

Source: Oecd, National Accounts; Labour Statistics.

The first is the pessimistic view, quite popular on the mass-media that unemployment is the irreversible result of fast technical change. This is disproved by the positive association of output, employment and productivity growth during the 'golden age'. Also mainstream economists tend to reject this thesis.[3]

The second view points to the fact that, after all, at least up to the recent recession that began approximately in the early nineties, the rate of job creation in the OECD countries has not been disappointing compared to the sixties (see Dell'Aringa, 1995): table 3.4 shows that from 1960 to 1970 employment increased in Europe by 2.9% and in the US by 20.6% against 9.4 and 18.6, respectively, between 1980 and 1990. Accordingly, it is argued, the *increase of labour supply* and not the lack of job opportunities is mainly responsible for increasing unemployment, particularly in Europe[4]. By contrast, North America successfully absorbed much higher growth rates of labour supply for significantly longer periods of time (see table 3.1).[5]

The increase of labour supply is certainly part of the European unemployment problem. However, the force of the argument that the pattern of job creation in Europe has been better in the recent past compared to the 60s is diminished once the decline of the agricultural sector that took place, particularly in continental Europe, during the sixties, is taken into account. Table 3.4 shows that in Europe over the decade 1960-70 the primary sector lost 11 millions jobs. This, set against a gain of over 15 million in the industrial and service sectors, reduced the *net* job creation to only 4 millions jobs. Still in the 70s Europe was loosing almost 6 million rural jobs. In Europe the growth rate of employment in the extra-agricultural sectors in the 60s was higher than in subsequent periods (14.5% in the '60s against 9.9% and 12.3% respectively in the 70s and 80s), in spite of higher productivity growth. In the US too the growth rate of employment (both total and extra-agricultural in this case) was higher in the 60s.

Looking at the OECD countries as a whole, the major explanation of the employment performance is in output growth rates. Table 3.6 shows that consistent with our approach to the forces behind accumulation (§ 3), in the 1960s two major components of autonomous expenditure - exports and government expenditure in final consumption - were also growing at a faster rate than in the 70s. The 1980s witnessed a further marked decline in their growth rates[6].

Tab. 3.4 - Employment patterns in Europe and North-America. 1960-1990

	19 60		19 70		19 80		19 90	
	Europe	North America	Europe	North America	Europe	North America	Europe	North America
				ABSOLUTE EMPLOYMENT LEVELS				
Agricolture	37.6	6.3	26.5	4.2	20.7	4.1	18.8	3.9
Industry	55.3	24.1	57.5	29.5	54.8	33.4	51.7	34.0
Services	49.8	41.4	62.8	52.9	77.4	72.5	96.8	92.6
Total	142.7	71.8	146.8	86.6	152.9	110.0	167.3	130.5
				ABSOLUTE VARIATIONS				
	1960-70	1960-70	1970-80	1970-80	1980-90	1980-90		
Agricolture	-11.1	-2.1	-5.8	-0.1	-1.9	-0.2		
Industry	2.2	5.4	-2.7	3.9	-3.1	0.6		
Services	13	11.5	14.6	19.6	19.4	20.1		
Total	4.1	14.8	6.1	23.4	14.4	20.5		
Total extra-agric.	15.2	16.9	11.9	23.5	16.3	20.7		
				PERCENTUAL VARIATIONS				
Agricolture	-29.5	-33.3	-21.9	-2.4	-9.2	-4.9		
Industry	4.0	22.4	-4.7	13.2	-5.7	1.8		
Services	26.1	27.8	23.2	37.1	25.1	27.7		
Total	2.9	20.6	4.2	27.0	9.4	18.6		
Total extra-agric.	14.5	25.8	9.9	28.5	12.3	19.5		
Labour force	4.8	18.7	7.3	28.7	10.8	16.6		
GDP	59.0	46.7	33.8	32.9	26.1	28.2		

Source: Oecd, Labour force statistics, various years.

Tab. 3. 5 - Exports and Government expenditure in final consumption. Annual growth rates at 1990 prices and exchange rate.

EXPORTS

	1960s	1970s	198Os	1990-93
Oecd	11.5	7.9	6.0	4.1
Oecd-Europe	11.2	7.0	5.6	3.5
EC	11.4	7.1	5.6	3.3

GOVERNMENT EXPENDITURE IN FINAL CONSUMPTION

	1960s	1970s	198Os	1990-93
Oecd	4.9	3.0	2.6	1.0
Oecd-Europe	4.8	4.0	2.2	1.5
EC	4.6	3.9	2.0	1.6

Source: Oecd, National accounts.

3.2. Policy prescriptions

3.2.1 The need for demand management policies

From the above it can be concluded that an alleged intensification of technical innovation cannot be regarded as the cause of current high unemployment rates. The cause could be seen in the change in policy orientation in most industrial countries from full-employment objectives towards anti-inflationary objectives. In addition, the changed international environment has decreased individual countries ability to increase their export levels, and has made balance of payment constraints to expansionary policies more stringent. The target of monetary stability has also been the main consideration that has affected decisions concerning monetary unification in the EU, and the resulting deflationary stance of economic policies has become an issue of public concern in most European countries.

According to the alternative view, macro-policies that affect the level of aggregate demand have not only cyclical but also persistent effects. This is because aggregate demand affects the decisions to invest and hence the creation of productive capacity and the output level in subsequent periods. *Structural* unemployment in this view can be defined in a way very different from current mainstream definitions of the natural unemployment rate or NAIRU. It is the unemployment level associated not to cyclical phenomena of underutilization of the existing productive capacity, but to a productive capacity which cannot - due to both its size and the techniques it incorporates - give employment to the entire labour force. Macro-policies can be effective in curing this structural unemployment in so far as by sustaining final demand they can stimulate higher investments and higher output growth[7].

3.2.2. The role of services

It is sometimes objected that higher growth rates of output, by stimulating higher productivity growth, would not in fact contribute much to employment creation. This requires some consideration of the sectors more likely to expand in a growing environment. There seems to be a general consensus as to the role of the service sector as the main source of future jobs in industrial economies (e.g. EC, 1993; OECD, 1994). In contrast, the manufacturing sector is not expected to supply much employment in the future given (a) the absence of major product innovations whose stimulus to consumption patterns is comparable, say, to the automobile or the domestic appliances; and (b) because of the higher productivity growth in manufacturing and competition from NIC's countries[8]. Nonetheless manufacture can still be an important source of jobs. Tables 3 and 4 show that the in spite of the continuous fall of its share of GDP, in

North America the manufacturing sector contributed in absolute terms to job creation, whereas the opposite happened in Europe.[9] On the other side, many services may be the objects of wide organisational and technological reshuffling. With these *caveats*, it is still reasonable to maintain that it is the service sector that will contribute more to job creation.

On the demand side an expansion of employment in this sector does not seem to meet limits other than the ability to pay of the potential consumers. To give an example, in many industrialised countries there will be a growing need of personal services (the least subject to productivity gains) from the elderly population. But the fact that most (low productivity) personal services are costly (Baumol, Bowen, 1965) might hinder their expansion. Three alternatives seem to be open at present to make possible an expansion of demand in this area. One is a larger social inequality in income distribution that would allow one part of the community to afford cheap personal services supplied by the other section. This is what often happens in developing countries and, possibly, in those industrial economies where labour market de-regulation has gone most far. A second increasingly popular road is to develop a so-called 'third' or 'non-profit' sector (see prof.G.Lunghini and other contributions in *Politica ed Economia,* 1995; Rifkin, 1995) that would provide affordable service on the basis of a self-restrained wage policy on the part of the employees (*plus* donations by the private sector, voluntary work and tax relief and subsidies by the State). The third traditional road is the public supply of services in which the State acts as direct employer and subsidises the supply of services by income re-distribution through the tax system.

The first route is evidently open to objections on the ground of social acceptability, and might not in the long-run be really viable in advanced, democratic countries. The second one, it might be feared, could pull together the drawbacks of both the first (as it implies underpaid workers) and the third (as it receives public subsidies). As far as most of the personal services are concerned (including education, health, assistance to the elderly), it is indeed possible, as shown by the past positive experiences of many European countries, that the third system is the most efficient road (see Prof. A.Graziani in *Politica ed Economia*, 1995)[10].

3.2.3 Reduction in working time

Another popular but little investigated employment policy relies on the reduction of working-time. It is not easy to draw general trends for different periods and countries given the changing nature of jobs, e.g. the diffusion of part-time jobs and multiple jobholding, rates of absenteeism, overtime, different holidays etc. (Bosch et al, 1994).

The general opinion is that the long-period trend has been of a reduction of the working hours (e.g. Maddison, 1991, p.137), although the opposite has been true for the early stages of capitalism before the reduction became an objective of organised labour. According to Maddison's figures (ibid., table 5.3), the reduction in selected industrial countries has been, if anything, less substantial during the 'golden age' 1950-73 compared to other periods. This is interesting since it shows that it was mostly the high rates of growth that compensated for productivity gains, and not the reduction in working hours, although the latter also played a role. Reductions after this period may have become more substantial due to labour-share schemes and, more importantly, for the diffusion of part-time jobs. It should be noted that the diffusion of part-time jobs has much more to do with the policies of 'flexibilisation' of labour markets than with the target of reducing working-time and increasing the number of employed people (Bosch et al., 1994, p.43). In addition, official figures for the Unites States quoted by Schor (1988) show that the annual per-capita worked hours in the manufacturing sector remained substantially constant from 1949 till 1985 - slightly declining from 1,976 in 1949 to 1924 in 1980, and up again to 1949 in 1985. Multiple jobholding and the fall of absenteeism in recent years would be part of the explanation. In European countries the reduction may have been more substantial (Bosch et al, table 2), less so in northern countries where the target of full employment by other means during the eighties made this a secondary objective. It can be argued that the reduction of working-time is a long-period process, which is eased, if anything, by output, employment and productivity growth and, therefore, it should not be taken as a substitute - but rather as a complementary policy - to more traditional full-employment policies.

3.2.4. Education, training and research

A general consensus between opposite theoretical persuasions is more easily found with regard to *supply-side policies* devoted to education, re-training, R&D and the like. In the first place, however, deflationary policies generally have led to cuts in the public expenditure in these sectors. In addition, analytical and empirical considerations suggest that supply-side policies are more effective in an expansionary environment which favours a rapid economic application of, say, training and research. Whatever training you provide people with, it will be of little use if the jobs simply are not there (for an orthodox sceptical view of training see, e.g., *The Economist*, April 1996).

Footnotes

[1] The OECD's *Jobs Study* is thus led to admit that: 'despite considerable effort, it has been hard to identify changes in the basic structural determinants of the natural unemployment rate that are large enough to account for the observed trend increase in actual unemployment during the 80s' (ibid., p.67).

[2] See the critical comments by J.G.Smith (1994) on Mr.J.Delors' 'White Paper on Unemployment' (EC, 1993).

[3] Looking at the same data presented here in table 3.1, a leading Italian labour economist concludes: 'The figures do not lend support to the idea, often claimed, that economic development in the last decades has mainly brought about increases in labour productivity while proving very poor in job creation. (...) In analytical terms we may say that the elasticity of employment with respect to output has increased (and not decreased) over time' (Dell'Aringa, 1995). On the same vein, noticing the similar rates of job creation over the 60s and 80s, Glyn argues that since output growth has not been higher over the last decade (26.1% in Europe against 59% in the 60s ...), then productivity growth has declined and it would be "absolutely wrong ...to blame technology from 'destroying jobs'" (Glyn, 1995, p.3).

[4] The Jobs Study does not seem to share this view (OECD, 1994, p.1).

[5] It may appear odd that mainstream economists seem to attribute to labour supply growth at the same time the high job creation in the US and the high unemployment in Europe. The rationale is in the alleged higher flexibility of the US labour market that, unlike the European, would have permitted employment creation to match the increase in labour supply.

[6] The OECD's *Jobs Study* discusses the possibility of using fiscal policy to expand the economy. The Report, notices with embarrassment that expansionary fiscal policies in the eighties were associated with a reduction in budget deficits (given 'buoyant tax revenues', p.65), which worsened precisely once less expansionary policies took place. It also argue that "[a]lthough the current recession was in part induced by policies aimed at correcting the earlier excessively loose and unbalanced policy stance in 1987-89, which had led to overheating in many OECD countries, it has also been more prolonged than expected so that 'overcorrection' has occurred", and concludes that there currently is a 'deficiency of demand' (p.66). In spite of the recognition that the lack of expansionary fiscal and monetary policies are the roots of high unemployment, their effectiveness is later denied with the basic argument that they would lead to higher inflation.

[7] Inflation is not a necessary consequence of expansionary policies, although it may result from a pressure to raise real wages when a fall in the unemployment rate is experienced, or from rising commodity prices following a general expansion in industrial countries. These, however, could be faced not by means of deflationary policies restoring high unemployment, but by means of income policies attempting to find a social consensus over income distribution. Income policies would be favoured by the productivity gains also associated to the faster output growth. From an institutional point of view, it should be recognised that an effective income policy would require stronger and not weaker centralised trade-unions.

[8] According to some commentators (e.g. Wood, 1994), European countries are 'exporting' jobs to the cheap labour-costs NIC's countries. It is likely that Europe is losing *low-skilled manufacturing* jobs in favour of NIC's countries. This could, however be compensated by the increase of *low-skilled jobs* in the *service sector* (jobs that by their very nature are difficult to export and that are badly needed by the European population). And the reason why the service sector low skill jobs have grown so slowly seems to be precisely that Effective demand in Europe has been growing too slowly.

[9] Note that the development of many services (financial, transport and communication, etc.) depends on the trends of the manufacturing sector.

[10] Most of the successful job creation in EFTA countries in the 80s has consisted of government jobs. Far from being considered as artificial jobs creation, the latter should be viewed as part of the long-run expansion of the service sector. Citizens may in many cases be ready to pay more, as tax payers and as consumers, for more reliable services (Meadows, 1996).

Chapter 4

Implications for the analysis of CIS data: from micro to macro

This chapter links the general discussion carried out at the macro level in chapters 1, 2 and 3, to the micro-economic analysis of CIS data developed in the subsequent chapters. The difficulties of tracing the macro-economic implications of micro-economic behaviour are put forward. We conclude that from the analysis of data at enterprise level important results can be obtained concerning the technological specialisation of a country and the composition, by sector, firms' size and skill, of employment. In the case of the export performance, some macro-economic implications may be drawn.

By looking at CIS data we expect two order of results to become apparent:

(A) at the *micro-economic* level we want to assess and compare the employment and economic performance of different typologies of firms assessing, in addition, the impact of specific innovation related variables.

(B) at the *macro-economic* level we wish to draw some conclusions as to the overall impact of innovation on employment.

In principle, the first objective does not present particular obstacles. On the contrary, the second objective meets serious difficulties that we explore in this chapter.

4.1. Displacement effects

Recall that from the analysis presented in previous chapters we concluded that technological unemployment is *in principle* a possibility. We rejected the neoclassical compensation effects on the supply side but allowed for the existence of compensation effects on the demand side, either through the positive effects of innovations on gross investment and consumption and/or through policy intervention.

Looking at the manufacturing sector first, an single firm/industry can affect the output and employment levels of the economy either by *directly* expanding its production, or *indirectly* by increasing its demand for production goods from other firms/industries (e.g. investment goods). In either case it cannot safely conclude that the *direct* and *indirect* effects are a *net* outcomes since in principle, the displacement of competing firms or industries cannot be ruled out. In other words, the growth of one firm/industry may be accompanied by the decline of a competing firm/industry.

Looking at the economy as a whole, output and income growth in the manufacturing sector, although they may be associated to a decline of employment (as a consequence

of productivity growth), may generate output and employment growth in the service sector.

As a conclusion, output and employment patterns of innovating firms have not clear *net* effects on the manufacturing sector and the economy as a whole.

4.2. The impact on investment, consumption and exports

The arguments presented above (§ 2.3 and *appendix 2*) also show that one cannot *safely* argue that innovation pushes *gross investment* over the level that would have been established in the absence of innovations.

Given some favourable circumstances, however, product innovation may positively affect consumption levels, but, unfortunately, to assess this is out of the scope of our research (although we shall look at the different impact at firm level of product *versus* process innovations).

From chapter 2, we also concluded that in the case of *exports* more reliable conclusions can be drawn as to the positive effects of innovation on overall employment. Although, once again, at the level of the individual firm export growth may well lead to lower employment (since in principle productivity growth may overcome output growth), at the aggregate level the effects of exports on overall output and employment can be safely taken as positive.

4.3. Measuring the macro-impact of innovation on employment from micro-data: conclusions

All this considered, we may conclude that albeit interesting to investigate the different sales, employment, investment and innovation typology of innovating firms, and to compare these to 'control groups' (e.g. non-innovating units), much caution has to be observed in drawing macro-economic conclusions.

The comparison of the economic performance of firms with different innovation patterns is, of course, an important indication of the processes of structural change occurring in the economy, and as such it provides important information, e.g. for innovation policy. Information on employment mainly concerns the composition of employment, e.g. by firms' size, sector and skills, but not its *level.*.

Some reliable macro-economic conclusions can, however, be drawn on the basis of the export performance of innovating units.

PART II

The impact of innovation on employment in Italy: results from Community innovation survey 1990-1992.

PART II investigates the impact of innovation on employment in the Italian manufacturing sector on the basis of the Community Innovation Survey (CIS) for the years 1990-1992.

Chapter 5 compares the performance of a sample of almost 6,000 Italian innovating firms to that of a sample of over 9, 000 non-innovating firms and to a larger panel of over 26,000 firms. The latter is representative of the employment and economic performance of all the Italian firms with more than 20 employees. The results of some simple regression analysis are also presented.

Chapter 6 compares the performance of different *types* of innovative behaviour. Factor analysis and cluster analysis are used in this chapter. It also evaluates, by using discriminant analysis, the impact of different innovation-variables on the performance of innovating firms.

Methodological discussion and more technical results are reported in the appendices 3, 4 and 5.

Chapter 5.

Comparison of the employment performance of innovating, non innovating and all manufacturing firms

This chapter compares the employment and economic performance of innovating firms to that of non-innovating firms and to a panel representing all manufacturing firms with more than 20 employees. It emerges that innovating firms do not perform better in terms of employment and output, with the exception of small innovating firms. However, innovating firms have an important role in exports. This role has increased over the years 1990-92 compensating their difficulties in the domestic market. It can be concluded that, over the period 1990-92, although the *direct* impact of innovation on employment has not been positive, the *indirect* one through exports has been beneficial. In addition, investment related to the introduction of innovations may have softened the negative impact of the recession on the overall level of gross investment. Regression analysis confirms these results. However, it suggests some caution with regard to the positive effect of innovation on exports at the firm level.

We begin by comparing the employment and economic performance of three panels of firms over the period 1989-1992: (i) almost 6,000 innovating firms (IF), (ii) over 9,000 non-innovating units (NIF), both surveyed by CIS, and (iii) over 26,000 firms covered by the *Survey on the economic results of firms with more than 20 employees* (SERF). The latter panel includes the first two samples of IF and NIF. SERF has been useful not only as a control group, but also because it integrated the information available from CIS with data on employment and other economic variables.

The reader is strongly advised to read *appendix 3* first, where the limitations of the data sets are illustrated. In short, one should recall that:

(i) the employment figures are gross of 'temporary lay-offs' ('Cassa integrazione guadagni' or wage-supplementary fund)[1], so it tends to underestimate the real variations in employment;

(ii) total hours worked concern only blue-collars and include over-time. One should also keep in mind that the data are based on closed panels that do not take into account variations due to firms' births and deaths.

In this chapter, the statistical tables provide information according to:

(i) a classification of sectors between those where firms that carry out R&D activities prevail, and those where this is not the case; the two classes are defined *R&D-oriented* and *non R&D-oriented*[2]. This classification has been adopted to facilitate the illustration of the tables.

(ii) firms size, based on the class of employees firms belonged to in 1989.

The composition of the three panels of firms are shown in table 5.1. As expected, the set of IF comprises a larger share of R&D-oriented sectors and of medium and large firms. Nonetheless, over 5,000 firms with less than 200 employees are present among IF.

The *direct* impact of innovation on employment, hours worked, value-added and productivity over the period 1990-92 are illustrated first. The *indirect* impact on employment through the effects on exports and investment are described next. Subsequently, the impact on the output and labour-force composition is examined. Finally, the results of some simple regression analyses are illustrated.[3]

5.1. Impact of innovation on employment, hours worked, value-added and productivity growth

Main findings

Over the period 1990-92, IF performed better than NIF and SERF in terms of number of employees, but not in term of total hours worked and output. Various considerations lead us to believe that hours worked is a better indicator. It may be concluded that over this period the IF do not show a better employment performance than NIF and SERF. Small IF are the exception doing better than any other group both in terms of number of employees and of hours worked. Both indicators (employment and hours worked) show a fall in the use of labour-inputs for IF that innovated only in processes or only in products. Figures on gross job turn-over show that the process of creation and destruction of jobs has not been higher among IF. The growth rate of value added of IF has been lower than the average. The productivity level of IF is higher that the other groups. Over the same period, small IF (but also small firms in the other groups) have reduced their productivity-gap with respect to the average level. Over the period per-worked hour productivity growth of IF has been slightly higher than in the other groups. This is the result of a low growth rate of value added associated to a significant reduction of hours worked.

Tab. 5.1 - Distribution of panels of firms by sector and size (1) in 1989.

	INNOVATING FIRMS		NON INNOVATING FIRMS		SE RF	
	n.	%	n.	%	n.	%
Total	5962	*100.0*	9534	*100.0*	26642	*100.0*
Non R&D-oriented sectors	3225	*54.1*	7103	*74.5*	17912	*67.2*
R&D-oriented sectors	2737	*45.9*	2431	*25.5*	8730	*42.8*
20-199	5102	*85.6*	9315	*97.7*	24819	*93.2*
200-499	530	*8.9*	189	*2.0*	1274	*4.8*
Over 500	330	*5.5*	30	*0.3*	549	*2.1*

Note: (1) All innovating firms and non innovating firms encompassed by the Community Innovation Survey are included in the Survey on the economic results of firms (Indagine sul prodotto lordo) (see appendix 3).

Legenda:

R&D-oriented sectors:
Chemicals; Synthetic fibres; Machinery; Electronics, computers; Car industry; Other transports; Scientific instruments; Plastic & rubber.

Non R&D-oriented sectors:
Metal minerals mining; Metallurgy; Non metal.minerals mining; Non metal.minerals processing; Metal products; Basic food industry; Food & drinks; Textiles; Leather, Clothing & footwear; Wood & furniture; Paper & printing; Misc.other manufacture.

Source: Istat, CIS, SERF.

Tab.5.2 - Annual rates of growth of employment in IF, NIF and SERF by sector and size (1). 1990-92.
(percentages [2])

		1990	1991	1992	1990-92
INNOVATING FIRMS	**Total**	2.26	3.04	-4.04	0.28
	Non R&D-oriented sectors	*1.75*	*0.80*	*-2.87*	*-0.09*
	R&D-oriented sectors	*2.55*	*4.31*	*-4.68*	*0.49*
SIZE	20-199	4.86	1.54	0.78	1.83
	200-499	2.10	-0.29	-1.42	0.09
	Over 500	1.10	4.59	-6.90	-0.39
TYPE OF INNOVATION	Both prod.&proc.	2.69	3.86	-4.56	0.45
	Only proc.	0.16	-0.37	-1.37	-0.39
	Only prod.	1.38	0.66	-2.83	-0.21
NON INNOVATING FIRMS	**Total**	1.74	-0.66	-2.38	-0.45
	Non R&D-oriented sectors	*1.53*	*-0.70*	*-2.37*	*-0.52*
	R&D-oriented sectors	*2.33*	*-0.56*	*-2.40*	*-0.23*
SIZE	20-199	2.29	-0.44	-2.08	-0.09
	200-499	-0.45	-1.79	-4.51	-2.21
	Over 500	-2.91	-2.03	-3.18	-2.63
SERF	**Total**	1.67	1.19	-3.12	-0.11
	Non R&D-oriented sectors	*1.25*	*-0.18*	*-2.18*	*-0.38*
	R&D-oriented sectors	*2.15*	*2.70*	*-4.14*	*0.19*
SIZE	20-199	3.22	0.35	-0.50	1.03
	200-499	0.97	-0.60	-2.72	-0.79
	Over 500	-0.18	3.13	-6.93	-1.40
	NATIONAL ACCOUNTS (3)	0.50	-2.20	-4.30	-2.00

Legenda: see table 1.

Notes:
(1) Employment is gross of temporary 'lay-offs'.
(2) In this and in the following tables, the value for 1990-92 or 1989-92 are simple averages.
(3) Annual growth rates of number of employees in the manufacturing sector in equivalent full time

Source: ISTAT, CIS, SERF.

Tab. 5.3 - Annual rates of growth of hours worked in IF, NIF and SERF by sector and size (1) . 1989-92.
(percentages [2])

		1990	1991	1992	1990-92
INNOVATING FIRMS	**Total**	-0.57	-0.06	-4.33	-1.64
	Non R&D-oriented sectors	1.35	-1.52	-2.18	-0.79
	R&D-oriented sectors	-1.86	0.95	-5.77	-2.22
SIZE	20-199	2.83	0.00	-0.91	0.63
	200-499	-0.57	-2.97	-1.45	-1.64
	Over 500	-2.42	0.69	-7.02	-2.88
TYPE OF INNOVATION	Both prod.&proc.	-0.99	1.01	-4.68	-1.56
	Only proc.	1.24	-2.86	-1.67	-1.10
	Only prod.	0.51	-4.65	-4.53	-2.84
NON INNOVATING FIRMS	**Total**	1.10	-1.43	-3.64	-1.32
	Non R&D-oriented sectors	0.83	-1.18	-3.17	-1.17
	R&D-oriented sectors	1.89	-2.16	-5.04	-1.77
SIZE	20-199	1.66	-1.40	-3.93	-1.23
	200-499	-1.97	-1.83	-1.60	-1.77
	Over 500	-2.70	-1.04	-2.48	-2.03
SERF	**Total**	-0.41	-0.60	-3.70	-0.41
	Non R&D-oriented sectors	0.32	-0.92	-2.46	-0.27
	R&D-oriented sectors	-1.38	-0.17	-5.35	-0.59
SIZE	20-199	1.86	-0.87	-2.11	-0.23
	200-499	-0.83	-2.04	-2.63	-0.29
	Over 500	-3.99	0.55	-6.94	-0.77
	NATIONAL ACCOUNTS (3)	0.50	-2.20	-4.30	-2.00

Legenda: see table 1.

Notes:
(1) Only 'blue collars'.
(2) 1990-92: simple average.
(3) Annual growth rates of number of employees in the manufacturing sector in equivalent full time

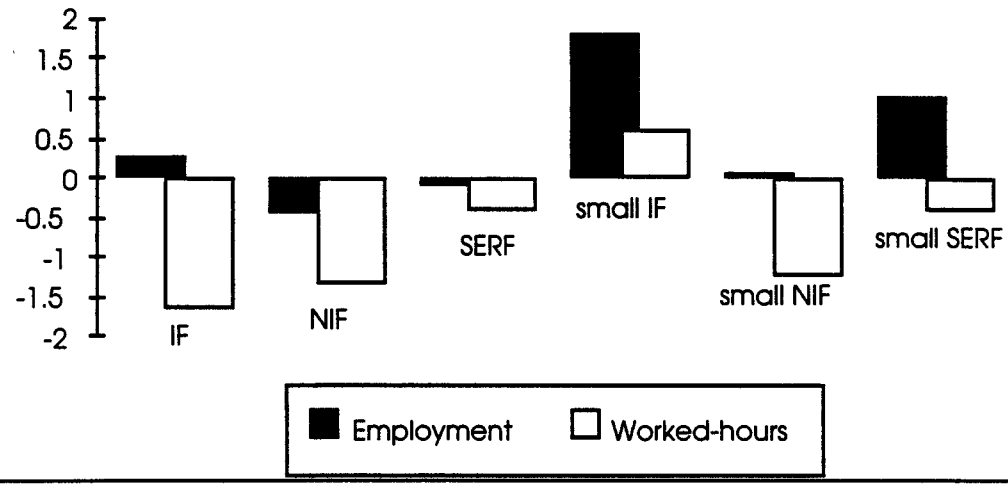
Source: ISTAT, CIS, SERF

Details

Employment and total hours worked

Over the period 1990-92[4], the average annual growth rate of employment of IF was 0.28% against -0.45% and -0.11% of NIF and SERF, respectively (fig. 5.1 and table 5.2). By contrast, the average annual growth rate of total hours worked of IF was -1.64% against -1.32% and -0.41% in NIF and SERF, respectively (fig. 5.1 and table 5.3).

Fig.5.1 - Average annual rates of growth of employment and hours worked over 1990-92.



The results of IF in terms of employment and hours worked change rates are clearly divergent.

The divergence is more apparent among IF and SERF in the years 1990 and 1991. In NIF, and in 1992 for all firms, the two indicators move together. The divergence is analysed in *Appendix 4.* It appears that in 1990 and 1991 the divergence in IF and SERF may be caused by some (the minority) of the firms increasing employment and hours worked, and the rest (the majority) laying-off workers and reducing hours worked. The reduction of hours worked by the second group was larger than the increase in the former, and this produced the negative sign for hours worked in 1990 and 1991. However, since our data do not take into account lay-offs, at least part of the reduction of employment by the second group is not shown in the data, and hence the positive sign prevails. We have also considered the possibility that the divergence can be explained by a substitution of white-collar workers for blue-collar workers. This process may have played some role especially among small firms where, however, white-collar workers are a less significant share of total employment. All this considered, hours worked appear to be a better indicator of the net variations in the use of 'labour-inputs'. This indicator is only a proxy for the variation of the *number* of employees, as it concerns only blue-collars and it includes variations in over-time.

Tables 5.2 and 5.3. show that among IF and SERF the R&D-oriented sectors do better than the non R&D-oriented sectors in terms of number of employees, but not in terms of hours worked. On both criteria, there is not much difference among NIF[5].

Looking at product and process innovations, we also have a mixed picture. IF that innovated either only in processes or only in products reduced both the number of employees and the hours worked (the average annual growth rates in the former group are -0.39% and -1.10%, respectively; and -0.21% and -2.84%, respectively, in the second group). IF that introduced both product and process innovations increased the number of employees, but reduced hours worked (0.45% and -1.56%, respectively). These data show that while process innovations do not favour a greater use of labour-inputs, it is not clear whether more favourable result can be expected from product innovations. To this regard, it should be noted that the negative impact of process innovations on the use of labour-inputs may be faster than the positive impact of product innovations, especially when a recession is approaching. A similar result regarding the negative impact of process innovations on employment is also obtained in Ch.6 below, using a different methodology.

Interesting enough, from the viewpoint of firm size, the two labour-input indicators provide more consistent results. In particular, both indicators, though to a different

degree, show that the average growth rates of employment and hours worked in small IF were 1.83% and 0.63%, respectively (see fig.5.1). Small firms do better than medium and large firms also among NIF and SERF, although only small IF show a positive value for both indicators. Only in 1992 small IF started to reduce hours worked while still showing a positive (gross) employment growth.

Gross job turn-over

In dealing with the divergence between average (gross) employment and hours worked figures, we have implicitly pointed to the underlying variety of behaviour at the firm level, with part of them expanding the use of labour-inputs, and others reducing it. Gross job creation and destruction, gross job turn-over for short, has attracted much attention in recent years as a measure of structural change (OECD, 1995). Small annual *net* changes in employment may be accompanied by large *gross* changes that result from the addition of the gross creation of new positions (expansions) and the gross destruction of existing positions (contractions). The values of gross job turn-over displayed in table 5.4 under-estimate the actual figures, since they are gross of lay-offs, do not take into account births and deaths of firms, and are limited to firms with more than 20 employees (gross jobs turn-over is usually higher in small firms)[6]. The table shows that the positive performance of IF in terms of employment results from the majority of firms having increased the number of employees (52.2%). Conversely, only a minority of firms (46.2%) were increasing hours worked.

The lack of labour market flexibility is seen by mainstream economists as an obstacle to structural change (see above chapter 3). While the results concerning gross job turn-over do not permit the rejection of the hypothesis that labour market rigidities have discouraged more structural change in the Italian manufacturing sector over the years 1990-92, they show that, *ceteris paribus*, IF have not seen greater structural change in terms of job turn-over this period compared to the other groups. Therefore, 'technological shocks' cannot be easily advocated as a source of labour market maladjustment requiring more flexibility. Moreover, the figures are roughly in line with those obtained for economies where the labour market is considered more 'flexible'[7].

Tab. 5.4 - Gross job turn-over (1) and share of firms increasing employment and hours worked in IF, NIF and SERF by sector and size. 1989-92
(percentages)

		JOB TURN OVER			% that in 1990-92 increased	
		1990	1991	1992	Employment	Hours worked
INNOVATING FIRMS	**Total**	12.4	18.9	11.7	52.2	46.2
	Non R&D-oriented sectors	13.7	11.7	13.7	52.0	48.9
	R&D-oriented sectors	11.6	23.2	10.7	52.4	43.1
	20-199	13.6	9.4	13.4	54.3	48.4
	200-499	16.3	8.0	13.9	41.3	35.3
	Over 500	10.4	28.3	9.4	36.7	30.6
NON INNOVATING FIRMS	**Total**	12.8	7.9	12.1	43.6	42.8
	Non R&D-oriented sectors	12.8	7.7	11.7	42.8	42.7
	R&D-oriented sectors	12.5	8.3	13.2	46.1	42.9
	20-199	12.5	7.9	12.2	44.0	43.0
	200-499	14.3	6.6	13.4	28.0	37.0
	Over 500	10.1	10.6	7.4	23.3	26.7
SERF	**Total**	13.7	13.2	12.9	45.2	44.5
	Non R&D-oriented sectors	14.3	8.4	13.4	43.9	45.1
	R&D-oriented sectors	13.0	18.4	12.4	47.9	43.3
	20-199	14.0	7.3	13.8	45.9	45.2
	200-499	15.0	7.6	15.6	37.8	36.6
	Over 500	12.0	26.2	9.4	34.2	29.9

Note: (1) Gross job turn-over is the sum of the positive and negative increments of employment, the negative variation taken in absolute value.

Source: ISTAT, CIS, SERF.

Value added and productivity

IF display an higher level of productivity (measured by per-capita or per-worked hour productivity) than the other two groups (table 5.5). This shows that the Italian CIS has discriminated quite well between innovating, high-productivity and non-innovating, low productivity firms. Other results show that the productivity-gap between small and large IF has shrunk over the period. For instance, per-hour worked productivity in small IF rose from 78.3% of the average level in 1989 to 83.3% in 1992. The same is true in terms of per-capita productivity and for the other two panels of firms.

The rates of growth of value-added in real terms (table 5.6) show that, over the period 1990-92, the performance of IF was the same of NIF and worse performance than SERF firms (the rates were 1.9% in IF and NIF, and 2.6% in SERF). The exception are the small IF that grew more than any other class of firms (the annual growth rates for small firms in the three groups are 6.3%, 2.5% and 4.6%, respectively).

Over the period, the average annual productivity growth rates[8] of IF, calculated as the variations of real value added/total hours worked (table 5.6), have been slightly greater compared to NIF and SERF (3.5%, 3.2% and 3.1% in the three groups, respectively). In terms of per-capita productivity the situation is reversed, with IF showing lower productivity growth. However, as explained above, figures based on number of employees are less reliable since they include lay-offs. Small IF show the highest rates of productivity growth on the basis of both indicators.

5.2. Impact of innovation on exports and investment

Main findings

Over half of Italian exports come from IF. Over the period, they have shown higher growth rates of exports and widened their share of total exports. Small IF have shown the largest growth rates, but still play a secondary role in total exports with small NIF and other small firms playing a more significant role.

The share of investment in value-added and the growth rates of investment are relatively higher in IF. Investment growth rates have been higher as an average over the period, and it has reacted less negatively to the recession.

Tab. 5.5 - Productivity levels (1) in IF, NIF and SERF by sector and size.1992.

	INNOVATING FIRMS		NON INNOVATING FIRMS		SE RF	
	Per-hour worked	Per-capita	Per-hour worked	Per-capita	Per-hour worked	Per-capita
Total	75.4	77.1	48.2	59.3	65.4	71.9
Non R&D-oriented sectors	65.2	77.7	45.9	57.7	56.2	68.1
R&D-oriented sectors	82.6	77.5	55.3	63.7	78.1	76.1
20-199	62.8	72.5	47.4	58.6	54.7	65.2
200-499	76.9	80.2	52.9	63.9	71.8	77.6
Over 500	82.6	79.3	53.1	61.5	81.9	79.4

Note: (1) Per hours worked: value-added on number hours worked (thausands of Italian liras);
Per-capita: value-added on numberof gross employees (millions of Italian liras).

Source: ISTAT, CIS, SERF.

Tab. 5.6 - Annual rates of growth of value-added in real terms and productivity in IF, NIF and SERF by sector and size (1). 1990-92.
(percentages)

		Value -added	Per-capita productivity	Per-hour worked productivity
INNOVATING FIRMS	**Total**	1.87	1.59	3.51
	Non R&D-oriented sectors	2.46	2.55	3.25
	R&D-oriented sectors	1.55	1.06	3.76
	20-199	6.30	4.47	5.67
	200-499	4.40	4.31	6.04
	Over 500	-0.35	0.04	2.53
NON INNOVATING FIRMS	**Total**	1.89	2.34	3.21
	Non R&D-oriented sectors	2.56	3.09	3.74
	R&D-oriented sectors	1.52	1.75	3.29
	20-199	2.46	2.56	3.70
	200-499	0.64	2.86	2.41
	Over 500	-3.59	-0.96	-1.56
SERF	**Total**	2.58	2.69	3.10
	Non R&D-oriented sectors	2.93	3.31	3.58
	R&D-oriented sectors	2.24	2.05	2.64
	20-199	4.55	3.53	3.76
	200-499	3.86	4.65	4.94
	Over 500	0.03	1.42	2.19
	NATIONAL ACCOUNT ACCOUNTS (2)	0.63	2.63	na

Legenda: see table 1.

Note:
(1) Productivity growth is calculated as the difference between the growth rates of value-added and those of employment and total hours worked, respectively.
(2) Manufacturing sector.

Source: ISTAT, CIS, SERF

Details

Exports

The share of exports in total sales (table 5.7) for IF is higher compared to the other two groups (the average values are 26%, 21% and 23% in the three groups, respectively, over the period 1989-92). The propensity to export of R&D-oriented sectors is larger than non R&D-oriented sectors both in the IF and SERF. The share of exports in total sales increases with firm size in the IF and SERF groups. In all groups the export share has increased over the period (from 25% to 27% in IF).

Export growth in real terms (fig 5.2 and table 5.7) has been higher in IF (the average annual rate have been 4.8% in IF, against 3.2% and 3.9% in NIF and SERF, respectively). Among IF, the highest growth rates are shown by non R&D-oriented firms (8.4%) and small firms (9.3%).

Let us now look at how exports from each of the three panels are distributed according to different classes of firms (fig.5.3 and table 5.8). Among IF, the R&D-oriented sectors and large firms have the largest export shares (73% and 61% respectively). The opposite is true for NIF, with non R&D-oriented sectors and small firms having the largest shares (67% and 82%, respectively). SERF, which is representative of the overall distribution of the Italian manufacturing sector, shows that the R&D-oriented sectors have the largest share of exports (58% against 41% of the non R&D-oriented industries). Interestingly, the weight of large firms precisely matches that of small firms, with both slightly over 40% of total exports. Comparing the structure of exports in 1989 and 1992, it can be appreciated that in all three group the share of small firms has increased, while that of the R&D-oriented sectors has remained roughly constant.

Fig.5.2 - Average rates of growth of exports over 1990-92.

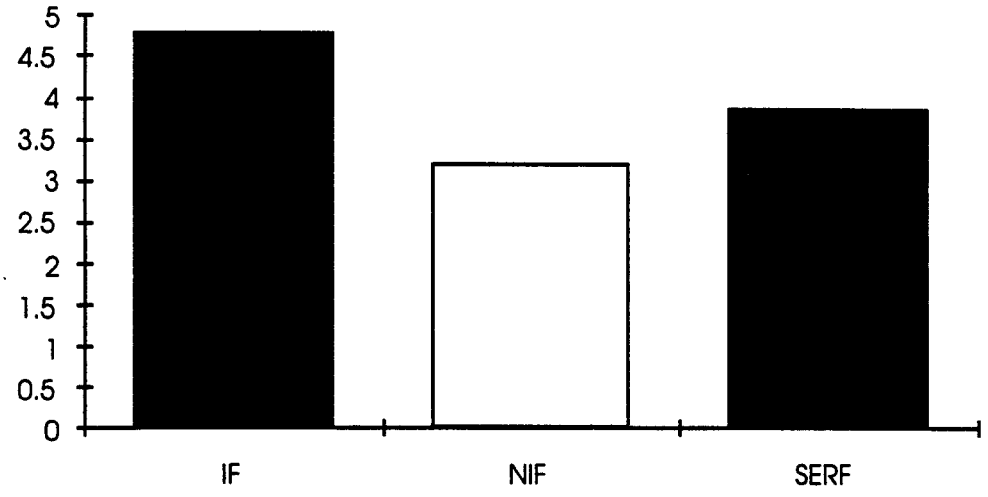


Table 5.9 provides additional information on how important are IF in the structure of Italian exports. Column (a) shows the share of IF in total exports for each class. As an average over the period 1989-92, 53% of total exports comes from IF (the share increased from 52% in 1989 to 54% in 1992) . The share of exports of IF is the highest in the R&D-oriented sectors and among large firms (67% and 79%, respectively, of total exports in each of these classes). It is lower among the non R&D-oriented sectors and small firms (34% and 30%). Column (b) shows the share of *total* exports (from all types of firms) covered by each class of IF. The 53% of total exports that come from IF is made of 14% from non R&D-oriented sectors and 39% from R&D-oriented sectors. It also results from 13% of total exports coming from small IF, 8% from medium IF and 32% from large IF. By way of comparison, column (c) shows the share of total value-added of each class of IF. R&D-oriented sectors and large firms display a larger share of total exports than their share of total value-added. Small IF have precisely the same share.

Tab.5.7 - Share of exports on sales and rates of growth of exports (in real terms) in IF, NIF and SERF by sector and size. 1989-92.

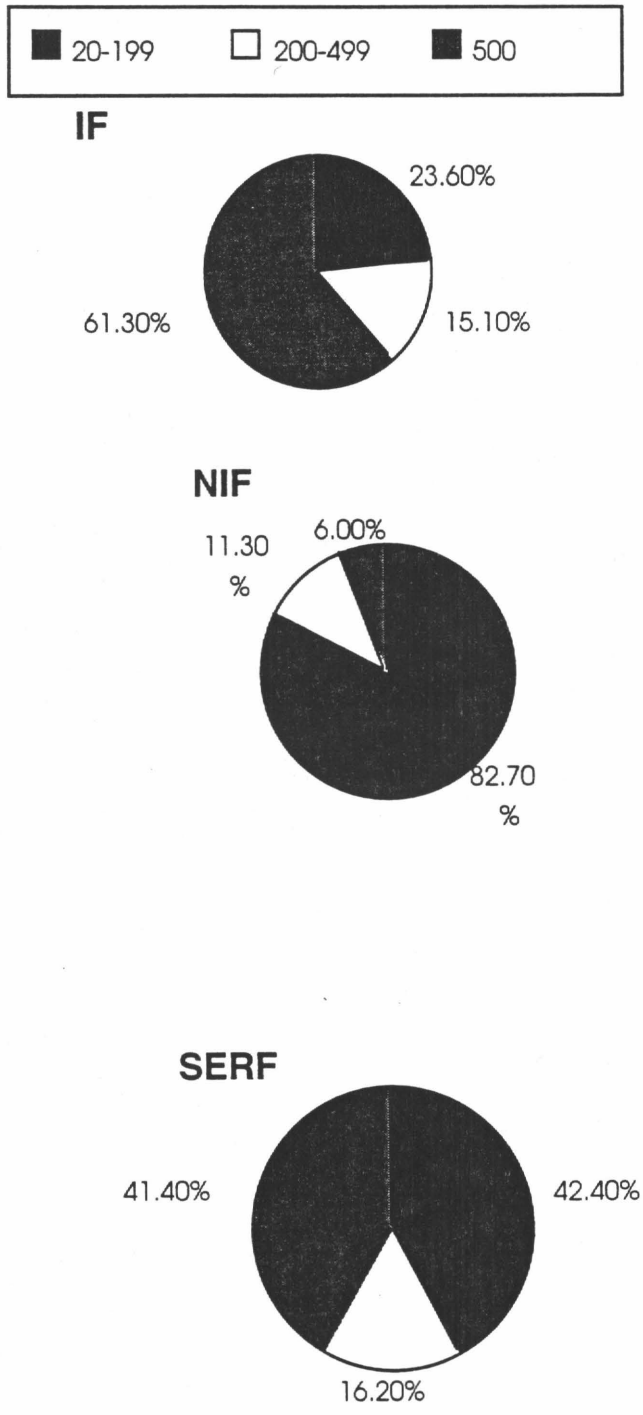
		EXPORTS/SALES			% average growth rates
		1989	1992	1989-92	1990-92
INNOVATING FIRMS	**Total**	0.25	0.27	0.26	4.81
	Non R&D-oriented sectors	0.17	0.18	0.17	8.39
	R&D-oriented sectors	0.30	0.32	0.31	3.55
	20-199	0.23	0.25	0.24	9.27
	200-499	0.28	0.28	0.27	5.58
	Over 500	0.25	0.27	0.26	3.03
NON INNOVATING FIRMS	**Total**	0.21	0.22	0.21	3.21
	Non R&D-oriented sectors	0.19	0.20	0.20	3.98
	R&D-oriented sectors	0.27	0.27	0.27	1.63
	20-199	0.21	0.22	0.21	4.25
	200-499	0.24	0.23	0.24	-0.13
	Over 500	0.23	0.21	0.23	-3.61
SERF	**Total**	0.23	0.24	0.23	3.90
	Non R&D-oriented sectors	0.18	0.19	0.18	5.40
	R&D-oriented sectors	0.29	0.30	0.29	2.83
	20-199	0.21	0.23	0.22	6.67
	200-499	0.25	0.25	0.25	2.85
	Over 500	0.25	0.26	0.25	1.64
	NATIONAL ACCOUNTS (1)				3.40

Legenda: see table 1.

Note: (1) Manufacturing sector.

Source: ISTAT, CIS, SERF

Fig.5.3 - Distribution of exports by firms' size over 1989-92.



Tab. 5.8 - Distribution of exports in IF, NIF and SERF by sector and size. 1989-92
(column percentages)

		1989	1992	1989-92
INNOVATING FIRMS	*Non R&D-oriented sectors*	26.1	26.8	26.3
	R&D-oriented sectors	73.9	73.2	73.7
	20-199	22.3	24.8	23.6
	200-499	15.1	15.3	15.1
	Over 500	62.6	59.9	61.3
	Total	100	100	100
NON INNOVATING FIRMS	*Non R&D-oriented sectors*	67.5	67.8	67.5
	R&D-oriented sectors	32.5	32.2	32.5
	20-199	81.8	84.3	82.7
	200-499	11.5	10.4	11.3
	Over 500	6.8	5.3	6.0
	Total	100	100	100
SERF	*Non R&D-oriented sectors*	41.5	41.5	41.3
	R&D-oriented sectors	58.5	58.5	58.7
	20-199	41.0	43.9	42.4
	200-499	16.4	15.8	16.2
	Over 500	42.6	40.3	41.4
	Total	100	100	100

Legenda: see table 1.

Source: ISTAT, CIS, SERF

Tab. 5.9 - Export shares of IF by sector and size.

	Export share in each class (1) 1989-92 (a)	Export share of total exports (2) 1992 (b)	*Value-added share of total value-added 1992 (c)*
Total	0.53	0.53	*0.48*
Non R&D-oriented sectors	0.34	0.14	*0.17*
R&D-oriented sectors	0.67	0.39	*0.31*
20-199	0.30	0.13	*0.13*
200-499	0.50	0.08	*0.07*
Over 500	0.79	0.32	*0.28*

Note:
(1) Exports of IF in class j/Total exports from class j by firms included in SERF.
(2) Exports of IF in class j/Total exports by all firms included in SERF.

Legenda: see table 1.

Source: ISTAT, CIS, SERF.

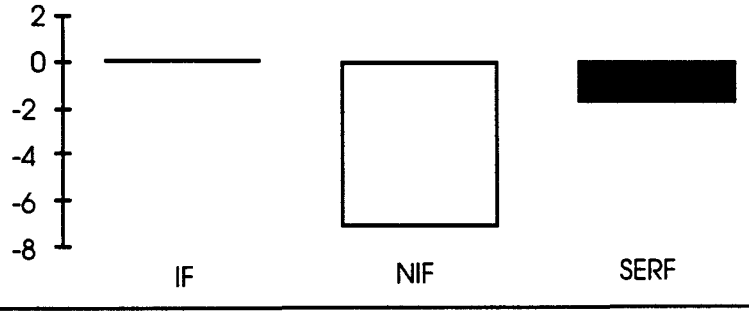
Two main results emerge from these tables. First, IF show a major and increasing role on total exports. The R&D-oriented sectors and the largest companies have the largest share of exports from IF. None the less, exports from IF in the non-R&D-oriented sectors and from small IF shows higher growth. Secondly, small IF, although they have increased their weight in exports, still play a secondary role on total exports. Only 13% of total exports come from small IF as compared to a share of total exports from all small firms of above 40%. All in all, the figures from CIS confirms the restructuring of Italian exports toward the most traditional end of the industrial-spectrum, although this is accompanied by an increasing innovative content of traditional productions.

Investment

The share of investment in value added is higher in IF compared to NIF and SERF (over the period 15%, 10% and 13%, respectively, see table 5.10). In all groups, the non R&D-oriented sectors show the highest share. This may depend on the relevance of embodied innovations in these sectors.

Over the period 1990-92, IF exhibit a positive average annual rate of growth of investment in machinery calculated in real terms (0.12, see fig. 5.4 and table 5.11). The opposite happens in the other two groups (-7.08 and -1.85, respectively).

Fig.5.4 - Average rates of growth of investment over 1990-92.



The comparison of the behaviour of firms over the cycle is particularly important in view of the Schumpeterian thesis of a 'compensation effect' to technological unemployment' on the demand side through 'autonomous investment' (see chapter 2 and appendix 2). It can be seen (fig.5.5) that IF were still raising investment in 1990 during the final phase of the expansion, when many classes of NIF were already decreasing it[9]. In 1991 investment growth was still positive in IF whereas it was negative in the other two groups. Finally, in 1992 investment fell less in IF than in NIF and SERF.

Tab. 5.10 - Share of investment (1) on value-added in IF, NIF and SERF by sector and size. 1989-92.

		1989	1992	1989-92
INNOVATING FIRMS	**Total**	0.14	0.15	0.15
	Non R&D-oriented sectors	0.15	0.16	0.16
	R&D-oriented sectors	0.14	0.14	0.14
	20-199	0.13	0.13	0.13
	200-499	0.15	0.12	0.14
	Over 500	0.15	0.16	0.16
NON INNOVATING FIRMS	**Total**	0.11	0.09	0.10
	Non R&D-oriented sectors	0.11	0.09	0.10
	R&D-oriented sectors	0.10	0.08	0.09
	20-199	0.11	0.08	0.09
	200-499	0.13	0.10	0.11
	Over 500	0.16	0.13	0.18
SERF	**Total**	0.13	0.13	0.13
	Non R&D-oriented sectors	0.13	0.13	0.14
	R&D-oriented sectors	0.13	0.12	0.13
	20-199	0.12	0.11	0.11
	200-499	0.14	0.12	0.13
	Over 500	0.15	0.15	0.15

Legenda: see table 1.

Note: (1) Investment in machinery.

Source: ISTAT, CIS, SERF.

Tab. 5.11 - Annual rates of growth of investment (1) in real terms in IF, NIF and SERF by sector and size. 1989-92.
(percentages)

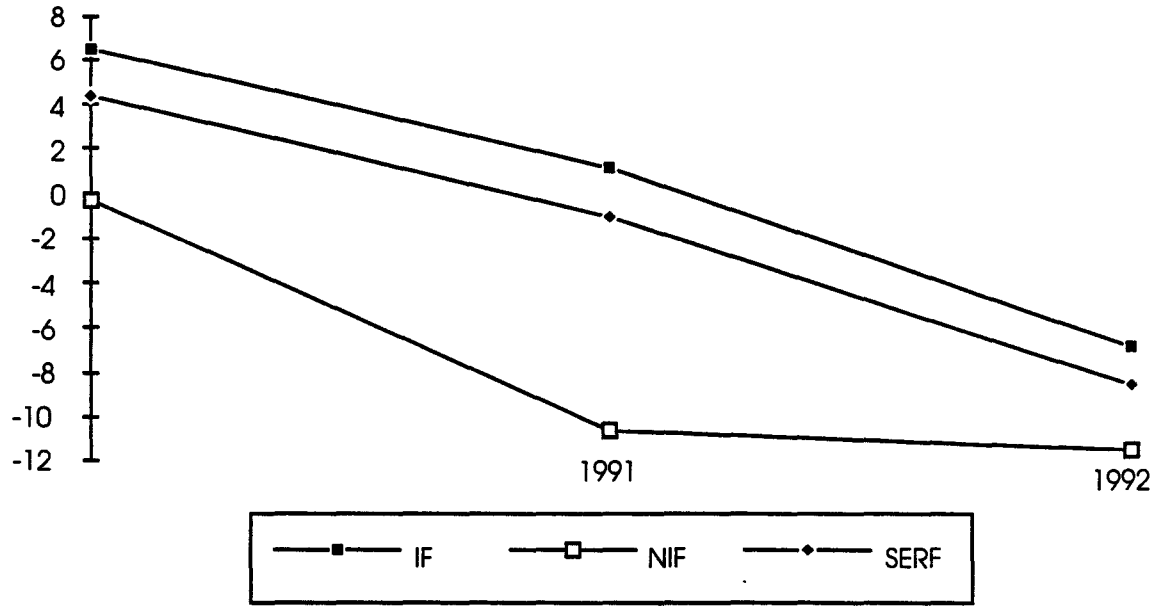
		1990	1991	1992	1990-92
INNOVATING FIRMS	**Total**	6.44	1.14	-6.77	0.12
	Non R&D-oriented sectors	14.57	6.82	-10.70	3.08
	R&D-oriented sectors	1.78	-2.53	-3.96	-1.58
	20-199	8.01	2.09	-6.25	1.13
	200-499	6.43	-3.08	-10.90	-2.70
	Over 500	5.85	1.73	-6.09	0.37
NON INNOVATING FIRMS	**Total**	-0.35	-10.69	-11.49	-7.08
	Non R&D-oriented sectors	2.73	-14.02	-11.58	-7.30
	R&D-oriented sectors	-8.92	-0.27	-11.22	-6.45
	20-199	-1.18	-10.45	-9.08	-6.51
	200-499	-7.20	-9.55	-13.09	-9.02
	Over 500	20.31	-14.42	-32.17	-10.05
SERF	**Total**	4.42	-1.07	-8.58	-1.85
	Non R&D-oriented sectors	8.40	-0.78	-9.78	-0.99
	R&D-oriented sectors	0.34	-1.39	-7.23	-2.74
	20-199	2.01	-3.70	-3.10	-1.60
	200-499	4.38	-0.87	-14.62	-3.89
	Over 500	6.80	1.34	-11.34	-1.35
	NATIONAL ACCOUNTS (1)	4.3	1.7	-1.5	0.5

Legenda: see table 1.

Note: (1) Investment in machinery in manufacturing sector.

Source: ISTAT, CIS, SERF

Fig.5.5 - Annual rates of change of investment. 1990-92.



5.3. Impact of innovation on the composition of output and employment

Structural change is the change in the composition of industrial and employment structure that results from technical change, from changes in the position of one country in the international division of labour and as an outcome of economic growth. Structural change is visible only over long periods of time. In addition, our data do not take into account births and deaths of firms, so that they under-estimate structural change. Therefore, we limit ourselves to few comments.

Main findings

Over the period, in all groups, the share of labour-inputs and output of R&D-oriented sectors and large firms has fallen at the expense of the non R&D-oriented sectors and small firms.

The share of women in the total and white-collar labour force is lower in IF than in the other two groups. In addition, it is lower in R&D-oriented sectors and in large firms. There are not perceptible changes over the period.

The share of white-collar workers is higher in IF and, among them, higher in R&D-oriented sectors. The share is slightly increasing over time. It is not possible

to say whether this is a cyclical phenomenon (the recession usually hits blue collar workers first), or a structural change. Both factors are likely to be present.

Details

Output composition

In all groups, in terms of hours worked and of value-added, the share of non R&D-oriented sectors has increased from 1989 to 1992 in all groups (table 5.12). In terms of all the indicators (including in this case also the number of employees), the share of small firms has also increased in all groups. Among IF, for instance, the share of small firms has increased 1% in terms of employment, 2.2% in terms of hours worked, and 3.3% in terms of value -added.

Employment composition

The share of women is lower in IF (table 5.13), both in the total labour-force (21%) and in white-collar workers (25%) compared to the other two panels (34% and 38% in NIF, and 26% and 29% in SERF, respectively). The share is higher in non R&D-oriented and small units. There is no evidence of changes over the period.

The average share of white collar workers in IF is 33% against 20% in NIF and 25% in SERF (table 5.14). It is higher in R&D-oriented sectors and increases with size. There is an upward trend, especially in IF, from 32% in 1989 to 34% in 1992.

Tab. 5.12 - Distribution of employment, hours worked and value-added in IF, NIF and SERF by sector and size. 1989 and 1992.
(column percentages)

		EMPLOYMENT		HOURS WORKED		VALUE- ADDED	
		1989	1992	1989	1992	1989	1992
INNOVATING FIRMS	*Non R&D-oriented sectors*	36.3	35.8	40.2	41.2	34.9	35.6
	R&D-oriented sectors	63.7	64.2	59.8	58.8	65.1	64.4
	20-199	27.0	28.6	30.0	32.2	23.5	26.8
	200-499	14.6	14.5	14.7	14.7	13.8	15.0
	Over 500	58.5	56.9	55.3	53.2	62.7	58.2
	Total	100.0	100.0	100.0	100.0	100.0	100.0
NON INNOVATING FIRMS	*Non R&D-oriented sectors*	74.0	73.9	75.2	75.5	71.7	71.9
	R&D-oriented sectors	26.0	26.1	24.8	24.5	28.3	28.1
	20-199	84.3	85.2	85.4	85.6	82.5	84.2
	200-499	10.7	10.2	10.1	10.0	11.5	11.0
	Over 500	5.0	4.7	4.5	4.4	6.0	4.8
	Total	100.0	100.0	100.0	100.0	100.0	100.0
SERF	*Non R&D-oriented sectors*	52.8	52.3	56.8	57.7	48.8	49.6
	R&D-oriented sectors	47.2	47.7	43.2	42.3	51.2	50.4
	20-199	49.3	51.0	53.3	55.3	43.4	46.2
	200-499	15.0	14.7	14.5	14.4	15.2	15.8
	Over 500	35.8	34.4	32.2	30.3	41.4	37.9
	Total	100.0	100.0	100.0	100.0	100.0	100.0

Legenda: see table 1.

Source: ISTAT, CIS, SERF.

Tab. 5.13 - Share of women on total employees and 'white collars' by sector and size in IF, NIF and SERF. Average 1989-92.

	INNOVATING FIRMS		NON INNOVATING FIRMS		SE RF	
	1989 -92		1989 -92		1989 -92	
	On total employees	*On white collars*	On total employees	*On white collars*	On total employees	*On white collars*
Total	0.21	*0.25*	0.34	*0.38*	0.26	*0.29*
Non R&D-oriented sectors	0.23	*0.32*	0.32	*0.42*	0.26	*0.34*
R&D-oriented sectors	0.19	*0.22*	0.22	*0.33*	0.20	*0.25*
20-199	0.26	*0.34*	0.34	*0.40*	0.31	*0.36*
200-499	0.25	*0.27*	0.37	*0.33*	0.28	*0.29*
Over 500	0.18	*0.21*	0.34	*0.31*	0.19	*0.22*

Legenda: see table 1.

Source: ISTAT, CIS, SERF

Tab.5.14 - Share of 'white collars' on total employees in IF, NIF and SERF by sector and size. 1989-92.

		1989	1992	1989-92
INNOVATING FIRMS	**Total**	0.32	0.34	0.33
	Non R&D-oriented sectors	0.25	0.26	0.25
	R&D-oriented sectors	0.36	0.38	0.37
	20-199	0.25	0.27	0.26
	200-499	0.32	0.34	0.33
	Over 500	0.36	0.37	0.36
NON INNOVATING FIRMS	**Total**	0.19	0.20	0.20
	Non R&D-oriented sectors	0.17	0.18	0.18
	R&D-oriented sectors	0.25	0.26	0.25
	20-199	0.18	0.19	0.19
	200-499	0.23	0.24	0.23
	Over 500	0.28	0.27	0.27
SERF	**Total**	0.28	0.29	0.29
	Non R&D-oriented sectors	0.22	0.23	0.22
	R&D-oriented sectors	0.35	0.37	0.36
	20-199	0.22	0.23	0.23
	200-499	0.30	0.32	0.31
	Over 500	0.35	0.37	0.36

Legenda: see table 1.

Source: ISTAT, CIS, SERF.

5.4. Explorative regression analysis

A simple regression exercise using Generalised least squares has been accomplished on IF and NIF to test at the enterprise level the effects of being innovative on the growth rate of (gross) employment (Y_1), growth rate of hours worked (Y_2), the growth rate of exports (Y_3) and of value-added (Y_4). The independent variables were
Z_1 = a dummy variable indicating the introduction (or non introduction) of innovations over the period 1990-92;
Z_2 = firms' size measured by the number of employees in 1989;
Z_3 = industry firms belong to.

Table 5.15 shows the results of the exercise. The values of the multiple correlation coefficient R^2 are always low. This is hardly surprising in an exercise carried out on almost 6,000 observations using only few independent variables. Behaviour at the level of the individual firm can indeed depend on many factors, some of which of very specific nature, that are not easily captured by statistical surveys or by any simple model. Only in the case of the first two equations the global model is statistically significant (measured by the F-test).

Looking at the impact of the independent variables, being innovative has a positive and statistically significant effect on the rates of change of employment (Y_1) and hours worked (Y_2). Firms' size has a negative effect on both variables. However, this effect is statistically significant only in the case of employment. The sector firms belong to significantly affects both variables (the sign of the influence depends of course on the sector).

Being innovative influences positively the growth rates of exports and value-added, but the coefficients are not significant. The same is true for the negative effect of firms' size.

Comparing these results with those obtained from the tables, one should pay attention to the fact that in the regression analysis the rates of change of the independent variables in each firm have the same weight irrespective of the size of the firm.[10] The opposite is true in the tables (that are actually weighted averages of firms' growth rates). Therefore, the positive impact of innovation on the use of labour inputs shown by regression analysis strongly reflects the behaviour of small IF (that are by far the majority of the sample of IF), that we known from tables 5.2 and 5.3 to have shown a better outcome from this point of view. The fact that size does not show a significant effect on variations of hours worked (although the sign is negative, as expected), may depend on the fact that NIF are included, and that in terms of hours worked small NIF

do not present a relative performance as good as small IF. The fact that the sector has a significant influence is also consistent with the finding of the tables that among IF there were differences between R&D and non R&D-oriented sectors, the latter doing better in terms of hours worked.

Less expected is the absence of significant effects of being innovative and of size on export growth (although the signs of the coefficients are those expected). This result suggests that although at an aggregate level the performance of IF is better than that of NIF, at the firm level the effect of innovations on exports is less systematic, and although a number of IF may have significantly increased their exports, there is also a large number that have not.

5.5. Review of the chapter

The results of this chapter should be considered with some *caveats*. The limitations of the available labour-input indicators, the lack of information on firms' births and deaths and the short period covered by CIS, suggest that any conclusion about the *direct* impact of innovation on the performance of IF should be drawn with caution. The implicit assumption that the business cycle affects to the same degree IF, NIF and SERF firms should also be taken into account. Moreover, it should be recalled that IF have been defined on the basis of innovations introduced sometimes in the period 1990-92. This is a very loose definition of IF, since NIF and SERF firms may have introduced innovations before this period. On the opposite, IF may have introduced innovations at the end of the period (say in 1992), too late to affect their performance. Finally, chapter 4 showed the difficulties of drawing the macro-economic implications of the micro-economic behaviour. With these *caveats*, let us review the main findings.

IF as a whole do not perform better than the control groups in terms of output and labour-input growth. However, small IF exhibit the best employment and output performance of any other class of firms (to help the reader, fig.5.7 summarises some results concerning small IF and all IF, respectively). This is in line with similar results in other countries (OECD, 1994, 1995). It should be noted that small IF are only 20% of all small firms included in SERF, and that their encouraging employment outcome can have just resulted from the displacement of less competitive small firms.

Tab. 5.15 - Summary of regression analysis.

Statistical significativity of coefficients

Dep.var.s	*Coefficients*			
	b0	b1	b2	b3
Y1	xxxx	xxxx (+)	xxx (-)	xxxx
Y2	xxxx	xxx (+)	NS (-)	xxxx
Y3	NS	NS (+)	NS (-)	NS
Y4	xxxx	NS (+)	NS (-)	NS

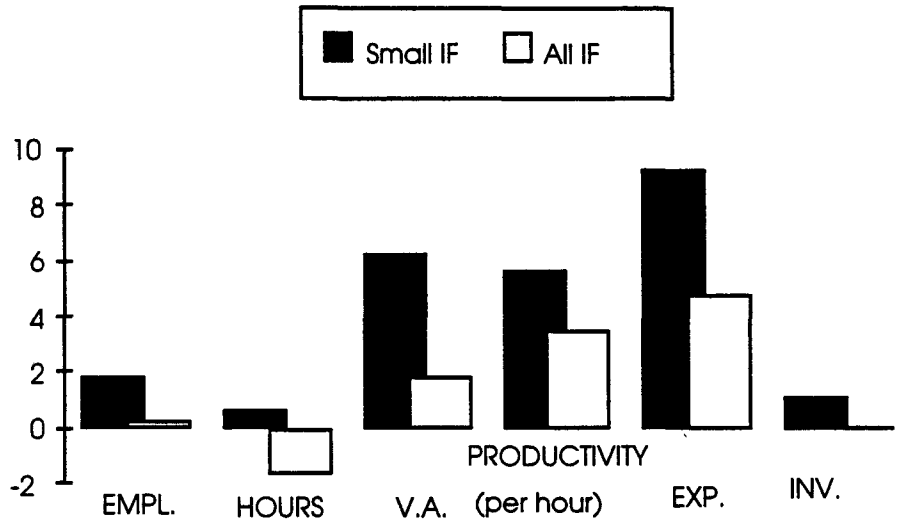
Global model	
F	R2
xxxx	0.012
xxxx	0.004
NS	0.002
NS	0.000

LEGENDA

N.S.	Not signif.
x	0,050<prob.<0,1
xx	0,025<prob.<0,050
xxx	0,001<prob.<0,025
xxxx	prob.<0,001

Source: ISTAT, CIS, SERF.

Fig.5.7 - Performance indicators of IF. Average annual rates of change over 1990-92.



In the light of chapter 4, some macro-economic conclusions may be derived looking at the impact of innovations on exports and investment.

CIS results show that over half of the total Italian exports (as measured by the panel of SERF) come from innovating firms, in particular from R&D-oriented sectors and large enterprises. Nonetheless, small firms play a significant role on total Italian exports covering over 40% of them. Yet, only one third of the small firm export share come from small IF.

Over the period, and before the devaluation of the Italian lira in September 1992, all types of Italian firms made an effort to expand their sales abroad. IF have been more successful than other types in the attempt, both in terms of share of exports on sales and in terms of exports growth. The best results are shown by the non-R&D-oriented sectors and by small IF.

In view of our theoretical approach and within the limits of the available data, the overall export performance of IF suggests that in Italy innovation has had a positive impact on employment through exports[11]. However, it is not possible to say to what degree this compensation effect has been sufficient to recover the jobs lost by the application of new process technologies. Certainly, although innovation is associated

with above average exports growth, this has not been sufficient to compensate for the fall in the rate of growth of domestic aggregate demand.

With respect to investment, the results show that IF have a higher propensity to invest, and that they cut their investment in plants and machinery later and to a smaller degree than the other classes of firms. This may actually lend some support to the Schumpeterian argument that it is mainly technical change and not effective demand that affects investment decisions through 'autonomous investment'.

Such a conclusion should be considered with much caution. In the short run innovation-related investment may be less sensitive to cyclical changes in effective demand. As a result, autonomous investment may have acted to an extent as a sort of stabiliser (a 'floor' in the terminology of 'cyclists') in the down-swing. Yet, the results suggest that, though to a lesser degree over the years considered compared to the other groups investment decisions by IF are also seriously affected by the fall in effective demand caused by the deflationary policies adopted in Italy and elsewhere.

In spite of their still important role, in Italy large, R&D-oriented IF continue to decline in favour of more traditional, non R&D-oriented small firms. Structural change in Italy has continued along the path set in the past two decades, showing the expansion of the small firms sector and the contraction of the large, more R&D-oriented companies.

Technical change is generally associated with changes in the skills required by production process and organisational innovations at various hierarchical levels. It has been traditionally debated whether innovations brought about a de-skilling or greater demand for better qualified labour force. There seems to be a general consensus that at present technical change, accompanied by competition from low-wage newly industrialising countries, is leading to the expulsion of low-skilled workers.

From our data it emerges that being innovative is linked to higher shares of qualified workers - measured through the share of white collar workers. The latter share has increased slightly over the period 1990-92, but it is not clear whether this was the result of a structural or of a cyclical change in the composition of the labour force. The fact that the share of white-collar workers has increased more in IF lends some support to the first hypothesis.

Innovation does not favour female employment. The latter is higher in small non-innovating firms belonging to traditional sectors. This confirms the conclusions of a large body of literature according to which women are relegated to the low-skilled positions in the labour force, which tend to be negatively affected by process

innovations (Bettio, 1988). The share of women on the labour force has not changed substantially over the period.

To sum up, the Italian experience over the period 1989-92 shows that innovation is linked to positive job creation in small firms, to above average export growth, to above average investment performance and to the expansion of the share of white collar workers. The impact on export can be regarded as having a positive effect, whether direct and/or indirect, on employment. The investment behaviour of IF may have had positive counter-cyclical effects on employment. It should be noted that the good performance of IF in exports and investment mainly concern the non R&D-oriented sectors. Therefore, over the years 1990-92 Italy has continued to specialise in her industrial model, consisting of a mixture of innovation and tradition (i.e. the ability to innovate within traditional/non-R&D based sets of small firms).

Footnotes

[1] 'Cassa integrazione guadagni' provides unemployment benefits to workers that, in principle, are still in firms' pay-rolls (and in this capacity they appear in our data as still employed). However, in some instances, workers may never return to their occupations.

[2] A *sector* was defined as 'R&D-oriented' if the sum of the firms doing systematic R&D plus 2/3 of those performing occasional R&D (both figures taken from CIS) was over 50% of the total number of firms in the industry. The list of sectors included in each class is on table 5.1.

[3] It should be observed that the average values shown in the tables (e.g. average growth rates) are weighted averages of the figures at the enterprise level. On the opposite, regression analysis is carried out on figures at enterprise level. In the first case large firms tend have a greater influence on the aggregate results than smaller units. In the second case all firms are on an equal foot independently of the size.

[4] The period considered includes the tail of the expansion that characterised the OECD countries in the second half of the eighties, and the beginning of the severe recession that marked the early nineties. The rates of growth of the Italian GDP over the three years were 2.1%, 1.2% and 0.7%. The corresponding rates of growth of dependent employment (in full-time equivalent) were 1.2%, 0.6% and -0.5% (source Istat, National accounts, 1988-94, mimeo).

[5] This is not surprising since very few firms that carry out R&D are included among NIF.

[6] Moreover, the values for 1991 are inflated by a large recruitment of workers by the main Italian car maker for a new plant in the South of the country.

[7] According to the (1994, tab.1.8) the gross job turn-over in Italy over the period 1989-92, taking into accounts only 'expansions' and 'contractions' of firms (as we have done here), has been 16.1% on average. The figure is higher than the one obtained here since it includes also firms with less than 20 employees. The correspondent figure for the United Kingdom is 9.1% (1989-91) and for the United States 8.6% (1989-91). The countries with more 'rigid' labour-markets show higher rates of turn-over. This is the case of France (with a rate of 13.6% over 1989-92), Germany (12.1% over 1983-90) and Italy.

[8] Productivity is measured by the ratio between value-added and the number of employees (or of total worked hours). Productivity growth is the difference between the rate of growth of value-added in real terms and that of employment (or of worked hours). It should be noted that over a short period of time, as the one considered here, the main factor affecting productivity is the business cycles. The latter affects the degree of utilisation of existing productive capacity, that is the output obtained by given amounts of physical and human resources. Technical change exerts its effects over longer periods of time.

[9] A lagged response of investment to demand growth is typical in Italy, especially among small firms.

[10] See above fn.3.

[11] A contrast emerges between the dismal performance of IF in terms of total output growth (see § 5.1) and the better performance in terms of exports growth. The economic policies pursued in these years seems to have affected more the domestic performance of IF than their external results. The fixed exchange rate policy strictly observed from the late eighties till the end of the period here considered has certainly advantaged foreign competitors in the Italian market. It may be possible that Italian firms have chosen to yield lower profit margins for unit of product sold abroad, in order to maintain their foreign market share, while maintaining their profit margins in the internal markets, suffering in terms of market shares from the cost advantages of foreign firms. In addition, the deflationary policies pursued by the Italian authorities to curb the public debt may have hit more IF, that possibly produce more

expensive/high quality goods, than more traditional products offered by NIF. Finally, cuts in the public procurement policy (that usually advantages national champions) and the diminished State support to large high-tech. companies belonging to the Public sector are also part of the explanation.

Chapter 6

The employment performance of different types of innovating firms and the impact of innovation variables

This chapter focuses upon different types of innovating firms that emerge from the combination of different innovation inputs and outputs. Interestingly, a large degree of variety of innovative behaviour is also present among small IF. Those types of small firms that rely more on traditional innovation sources and less on R&D exhibit a better performance. This result shows that in Italy the difficulties of the R&D-based firms concerns both large and small companies. Discriminant analysis is also used to assess the impact of some innovation variables on firms' performance. It confirms that firms' size is an important factor to explain the employment performance, and that the non-R&D sources of technical knowledge have a positive effect on performance.

6.1. Variety of innovative behaviour and economic performance: a multivariate analysis.

CIS provides a variety of data on the input and output of economic activities. The objective of this section is to use this information to classify innovating firms in order to compare the occupational and economic results associated with each type of innovative behaviour (Pavitt, 1984; Cesaratto, Mangano 1993; Cesaratto at al. 1996). Given the importance of small firms in job creation, as it emerged from chapter 5 and from the literature, a special classification has been carried out, in addition to the 'global one', concerning firms with less than 200 employees ('small-firms classification').

A set of variables has been selected from the CIS questionnaire that were considered the most effective in describing the innovative behaviour, and also the most suitable to the chosen statistical technique.

The selected variables can be grouped as follows:

innovation inputs:

- *typology of R&D activity*:
  [1] continuous; [1A] occasional; [1B] absent;
- *financial commitment to innovation*:
  [2] R&D/sales; [3] Investment on innovative fixed capital/sales; [4] Innovation costs/sales;
- *distribution of innovation costs among*:

[5] R&D; [6] Patent licences; [7] Design; [8] Trial production; [9] Market analysis[1];

innovation output:

- *distribution of sales among*:

[13] products innovated only from the point of view of processes; [14] incremental product innovations; [15] major product innovations.

Next, following a standard procedure, we applied *Factor analysis* to synthesise the informative content of innovation variables; and then *Cluster analysis* to synthesise the variety innovative behaviour of firms.

Factor and Cluster analyses
In dealing with many observed units (firms), each defined by many variables (the innovation-variables), it is useful firstly to synthesise the number of variables. Factor analysis identify a number of new variables, the principal components (PCs) each of which synthesises the contribution of one of more of the original variables. Subsequently, on the basis of the new synthetic variables, cluster analysis forces the units into homogeneous groups. Both methods help to reduce the variety of the phenomenon under scrutiny to a manageable size.

The first eight PCs explain 75% of the variability, and each one is associated to one or more of the original variables (see *appendix 5).*

6.2. The global classification

The first classification concerns 7,253 firms. 9 main groups or types of innovating firms were obtained (fig.6.1). First, we briefly describe each type. Then we compare their respective occupational and economic performance. Table 6.1 summarises the values taken by each cluster for the 15 variables used to classify firms[2].

The bottom row of the table shows the coefficients of variation - a measure of the 'dispersion' of values around their average - concerning innovation inputs (variables 1-11) and outputs (variables 12-15). The coefficient of the former group of variables are generally higher than those of the latter. It means that, with few exceptions, clusters are different more from the point of view of the sources of innovation than from that of innovative content of sales.

Tab. 6.1 - Results of 'global' cluster analysis. Values of the variables employed in the analysis

CLUSTER			Tipology of R&D					
n. *Definitions*	% of firms	Average size	Continuous	Occasional	Absent	R&D/sales °/°°	Investment/sales °/°°	Innov.costs/sales °/°°
1 *R&D-based*	28.9	317	100.0	0.0	0.0	21.8	24.5	28 7
2 *R&D intensive*	4.0	494	99.3	0.0	0.7	110.0	60.3	141.7
3 *Highly R&D-intensive*	0.6	270	73.8	16.7	9.5	372.4	175.3	429.1
4 *Occas. R&D-based*	15.2	72	0.0	100.0	0.0	14.9	38.5	24.5
5 *Design-based*	8.9	101	26.7	4.8	68.5	7.0	38.4	40.8
6 *Market-oriented*	9.9	115	21.8	2.0	76.3	4.6	57.6	33.3
7 *Prod.inn.s orient.*	5.4	78	42.2	10.5	47.3	15.2	54.2	29.1
8 *Invest.based*	25.2	65	0.1	0.0	100.0	0.0	84.0	3.7
9 *Licenses-based*	1.8	105	26.1	11.2	62.7	8.7	37.0	38.2
Total	100 (7253 firms)	167	40.7	16.7	42.7	17 4	53.6	31.0
Coeff.var.(1)			0.7	1.0	0.3	0.9	0.5	0.4

	Distribution of innovation costs:					Shares of sales:		
	R&D	Licenses	Industrial design	Trial production	Marketing	Not innovated sales	Process innovations	Product innovations
1 *R&D-based*	57.5	1.6	17.0	17.9	4.7	41.9	23.7	34 4
2 *R&D intensive*	60.2	2.7	16.8	15.9	4.4	36.5	18.2	45.4
3 *Highly R&D-intensive*	54.4	1.0	17.6	19.0	5.7	32.8	19.3	47.9
4 *Occas. R&D-based*	48.2	1.8	19.0	23.2	5.3	42.7	27.9	29.5
5 *Design-based*	7.9	1.0	74 0	7.9	2.2	34.1	25.9	40.0
6 *Market-oriented*	4.5	1.9	13.9	57.0	22.7	41.3	29.2	29.5
7 *Prod.inn.s rient.*	31.2	1.5	16.7	15.5	2.4	8.2	1.8	90 0
8 *Invest.based*	3.7	0.6	2.8	2.4	0.6	41.6	47.0	11.5
9 *Licenses-based*	8.8	77.6	2	6.9	1.2	40.3	31.3	28.5
Total	30.6	2.8	18.3	17.4	5.1	39.1	29.7	31.3
Coeff.var.(1)	1.6	0.6	0.4	3.1	4.8	0.5	0.7	0.8

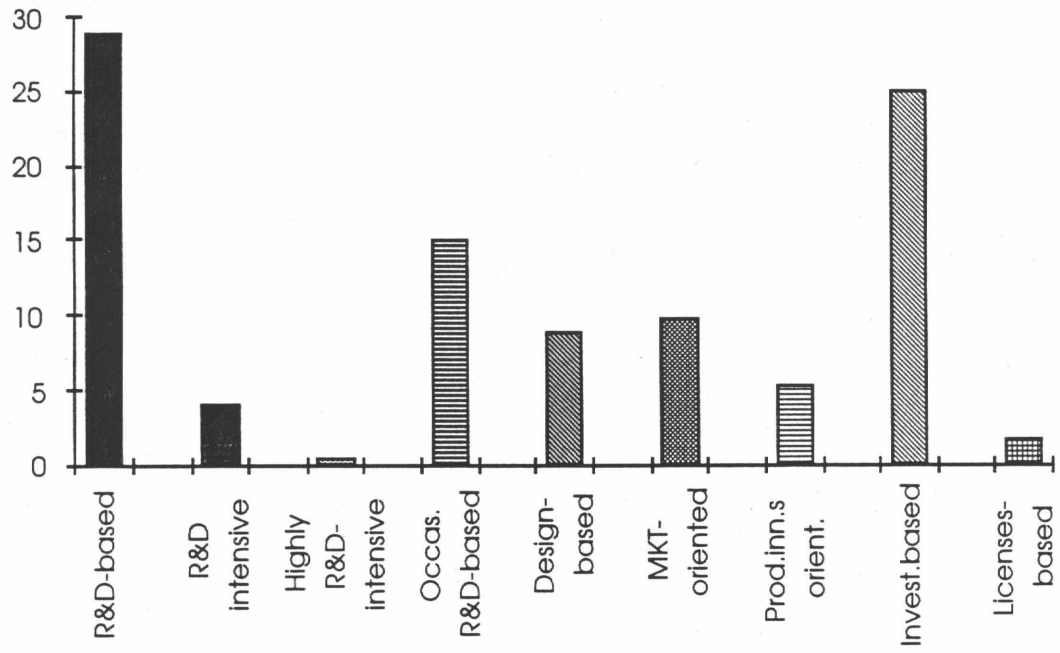
Note: (1) Standard dev./average

Source: Istat, CIS

6.2.1. Description of types of innovative behaviour

The different types are grouped in three sets: (a) R&D-based types, (b) types based on other internal sources of knowledge, (c) types based on external sources of knowledge. As in previous exercises (Cesaratto, Mangano 1993; Cesaratto et al, 1996), each type contains a variety of sectors, although some are more strongly represented than others. Symmetrically, each sector is spread over a number of types, although more concentrated in some of them. This shows the advantage of this classification, as an approach to the variety of innovative behaviour, over a sectoral classification.

Fig.6.1 - Types of innovative behaviour.



R&D-based clusters

1. R&D -based type

This is the largest type both in terms of employment and output[3]. The average size of the units is above average. Continuous R&D is the main innovation source. Both the shares of sales due to non-innovative products and to product innovations are above average.

2&3. R&D-intensive type, Highly R&D -intensive types

Both types translate the high financial commitment to R&D and innovative investment into an above-average share of product innovation[4]. The typical size is above average.

4. Occasional R&D-type

Occasional R&D is typical of a large group of below-average size units[5]. The financial commitment to innovation is below average. The shares of non innovated sales is above average.

Types based on other internal sources of knowledge

5. Industrial design-based type

The enterprises in this type are small on average and base their innovation mainly on industrial design[6]. The financial commitment to R&D and innovative investment is below average, but innovations costs are above average. Product innovations (typically of an incremental nature) are well above average.

6. Market-oriented type

Characteristic of this type is the high share of innovation costs attributed to trial production and marketing[7]. This suggests that firms in this type focus their innovative activities upon the next-to-market end of the innovation pipeline. The shares of sales devoted to innovative investment and innovation costs are slightly above average, whereas R&D does not seem very relevant, although one quarter of firms declared carrying it out on a continuous base. In spite of the market orientation, the share of non-innovative sales is only slightly above average.

7. Product-innovations oriented type

Firms included in this type show a below average size[8]. They are characterised by a well above average tendency to introduce product innovations (mainly radical innovations). Looking at innovation inputs, it is difficult to recognise a clear innovative behaviour since all the values are practically equal to the average values. One is brought to conclude that either (i) the remarkable rate of the introduction of product innovation is not linked to any particular innovation strategy, but to firm-specific entrepreneurial capacities; or (ii) that these firms tended to overestimate the number of their product innovations.

Types based on external sources of knowledge

8. Investment-based type

Firms included in this type show a very small average size[9]. They rely on embodied-innovations. Internal sources of innovation are practically absent (90%

of them did not answer to the question concerning the distribution of costs of internal sources of innovation) and the product mix has changed mostly as a consequence of process innovations, whereas product innovations played an insignificant role.

9. License-based type

The small average-size firms included in this small type base their innovations on the acquisition of licenses[10]. Most of them do not carry out R&D. Hence, the acquisition of external technology is not coupled with an internal effort to develop new knowledge.

To sum up, the results show that most of the IF carrying out continuous R&D are concentrated in one large type (28.9% of firms are in type 1). A smaller number is in type 2 (4%), and few other highly innovative firms in type 3. The most traditional innovation channel, based on the acquisition of new machinery, is still an important innovation source. A quarter of IF relies almost exclusively on this source (25.2% of firms are in type 8). It should be noted that embodied innovation may result in very significant technical change within firms, and that users often play an active role in the design of new machinery. In addition, this innovation channel may play a major role outside our sample of IF. Industrial design plays a minor role (8.9% of firms in type 5) compared to previous findings (Cesaratto, Mangano 1993; Cesaratto et al 1996)[11]. Cluster analysis associates trial production to marketing (type 6 contains 9.9% of firms), representing a 'next-to-the market' innovation type. According to survey results, innovation based exclusively upon the acquisition of licenses is a minor innovation channel (1.8% of firms are classified in type 9).

6.2.2. Comparison of the performance of different types

Table 6.2 shows the variations of employment, total hours worked and various other economic variables.

Employment and hours worked

Once again, the employment variations diverge from the variations of hours worked. Only two clusters show a positive performance in terms of these indicators. The first is the Highly *R&D-intensive* type (over the period 1990-92 the average annual growth rate of employment in this type was 47.2% and that of hours worked 34.9%). The second is the *Market-oriented* types (0.82% and 0.68%). The first type is clearly the case of a limited number of very successful highly innovative firms.

Tab. 6.2 - Comparison of the employment and value added growth rates of different types of IF. 1989 92
(percentages)

n.	CLUSTERS	Annual rates of growth of employment 1990-92	Annual rates of growth of hours worked 1990-92	Gross job turn-over 1990-92	Annual rates of growth of value-added (in real terms) 1990-92	Annual growth rate of per-capita productivity 1990-92	Annual growth rate of per-hour productivity 1990-92
1	*R&D-based*	0.07	-2.08	14.8	0.71	0.64	2.79
2	*R&D intensive*	0.09	-3.31	16.5	1.38	1.29	4.69
3	*Highly R&D-intensive*	47.25	34.91	81.4	66.21	18.96	31.30
4	*Occas. R&D-based*	0.89	-0.82	12.0	1.42	0.53	2.24
5	*Design-based*	1.29	-0.98	11.5	7.12	5.83	8.10
6	*Market-oriented*	0.82	0.68	17.0	5.05	4.23	4.37
7	*Invest.based*	-0.52	-1.51	10.4	3.09	3.61	4.60
8	*Prod.inn.s orient.*	1.01	-1.72	10.4	6.27	5.27	7.99
9	*Licenses-based*	-0.13	-2.87	8.3	3.62	3.75	6.49
	Total	0.37	-1.64	14.3	1.87	1.49	3.51

Source: ISTAT, CIS, SERF.

Two types exhibit a negative performance in terms of both indicators, the *Investment-based* (-0.52% and -1.51%) and the *License-based* types (-0.13% and -1.64%). The case of the *Investment-based* type may suggest a negative impact of process innovations on employment.

The two larger R&D-based types (1&2) show a positive but below-average performance in terms of employment, and a negative below-average result in terms of hours worked. Other results show that in the case of the *R&D-intensive* type there has been a substitution of white for blue collar workers (the share of white collar workers has increased by 4%), so that the fall in hours worked might, at least partially, be explained by a changing composition of the labour force.

The evidence shows that the highly innovative types 2 and 3 present a high job turn-over (16.5% and 81.4%, respectively, against an average of 14.3%). A high job turn-over is also found, however, in the more traditional *Market-oriented* type (17%). The high job turn-over of the *Highly R&D-intensive* type shows that, whenever it is necessary, firms can afford a high rate of job turn-over even in supposedly over-regulated labour markets.

Value-added and productivity

Over the period, all sectors show positive average annual rates of growth of value added. The *R&D-based* and *R&D-intensive* types show below-average rates (0.71% and 1.38%, respectively, against an average value of 1.87%). The *Highly R&D-intensive* type shows the highest growth rate (66.2%). *Design-based*, *Marketing-oriented* and the *Product innovations-oriented* types all show an above average performance.

The *Highly R&D-intensive* type shows the highest rates of growth of productivity both in per-capita and in per-hour worked terms. This result is associated to high growth rates both of value added and employment. Productivity growth is above average also in the *Design-based* the *Product innovations-oriented* types. This is the outcome of a good growth rate of value added and a fall of hours worked. By contrast productivity growth is below average in the *R&D-based* type. This outcome is associated to dismal growth rates of both value added and worked hours.

Exports and Investment

In terms of the share of exports in sales (table 6.3), the *Product-innovations oriented*, *R&D-based* and *Design-based* types show the highest shares (respectively 34%, 30% and 28% in 1992). On the contrary, the *R&D-intensive* and *Highly R&D-intensive types* present below-average shares (20% and 10%, respectively). Other data show that the

share of exports by the *Highly R&D-intensive* type has fluctuated over the period. This suggests that the presence of firms of this type in international markets is not firmly established.

Looking at the distribution of exports among different types, over 65% come from the *R&D-based* type (against a share of 54.5% of total employment). The export share becomes 71% if we add the *R&D-intensive* type. The other types show much lower shares.

Over the period, exports have grown in all types, with the exception of the *R&D-intensive* and *License-based* types. The *Highly R&D-intensive* type show the highest growth rate of exports. However, its share of total exports, although increasing from 0.18% in 1989 to 0.47% in 1992 is still tiny. The *R&D-based* type shows a slightly below-average growth rate of exports and the *R&D-intensive* type a negative one. This result is consistent with that of chapter 5 that showed that a better export performance is found among the non-R&D *sectors*. In terms of our types, the highest export growth rates can be find in the *Design-based*, *Investment-based*, *Market-oriented*, *Occasional R&D-based* and *Product innovation-oriented* types.

The *R&D-based* and the *Market-oriented* types display the highest share of investment in value-added. This result is partially in contrast to the one obtained in chapter 5. We found there that the non-R&D *sectors* had the highest share. However, at least the *Market-oriented* type is a non-R&D-based *type*.

Over the period the rate of growth of investment in machinery has been negative in the *R&D-intensive* type and in the *R&D-based* type. It has also been negative in the *Design-based* type. The most encouraging results occur in the *Highly R&D-intensive* type and in the *Market-oriented* type. It is positive in the *Occasional R&D-based, Investment-based, Product innovations-oriented* and *License-based* types. These outcomes are consistent with those of chapter 5 where investment was shown to be more sustained in the non-R&D-based sectors.

6.2.3. Final comments

The results of the 'global' cluster analysis reinforce the conclusions of chapter 5. On the one side, the two largest R&D-based types (1&2) display below average outcomes in terms of employment, hours worked, output, exports and investment growth. On the other side, they show a higher propensity to export. Actually, 73% of exports from all clusters come from these types. A small number of very innovative R&D based firms (type 3) show a more encouraging performance. The non R&D based types, in particular the *Market-oriented* type, generally show better results.

Tab. 6.3 - Comparison of the export and investment performance of different types of IF. 1989 92

	CLUSTERS	Exports/ Sales 1989-92	Distribution of exports (column %) 1989-92	Annual growth rates of exports (%) 1990-92	Investment/ value-added (1) 1989-92	Annual growth rates of investment (1) (%) 1990-92
1	*R&D-based*	0.28	65.19	4.51	0.16	-0.49
2	*R&D intensive*	0.20	8.42	-0.03	0.12	-4.68
3	*Highly R&D-intens.*	0.10	0.25	71.34	0.15	48.91
4	*Occas. R&D-based*	0.23	5.35	6.29	0.14	0.41
5	*Design-based*	0.27	4.91	12.70	0.13	-0.39
6	*Market-oriented*	0.21	6.05	6.01	0.16	8.49
7	*Invest.based*	0.19	6.08	6.16	0.14	0.52
8	*Prod.inn.s rient.*	0.33	2.70	5.78	0.14	1.43
9	*Licenses-based*	0.22	0.97	-0.67	0.15	1.69
	Total	0.26	100.00	4.81	0.15	0.12

Notes: (1) Investment in machinery.

Source: ISTAT, CIS, SERF.

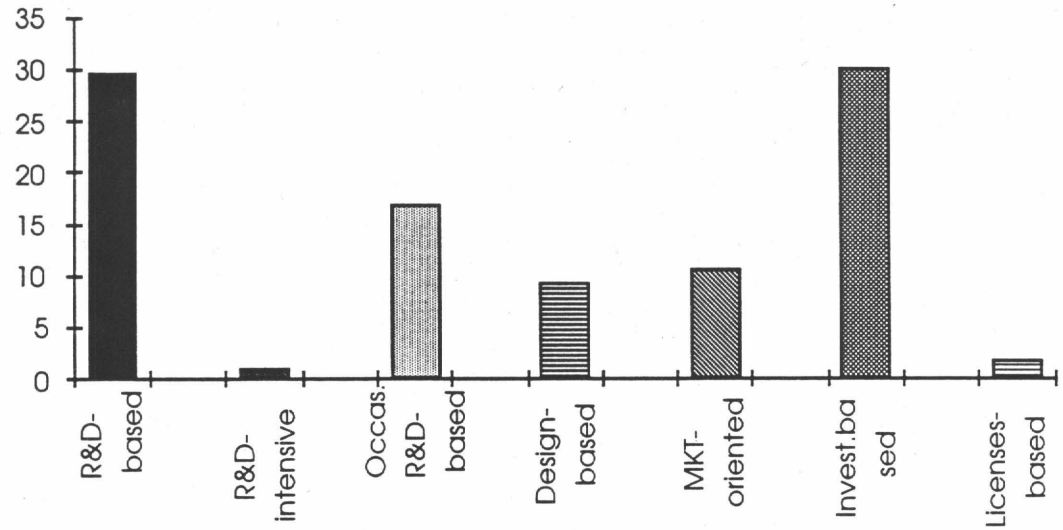
6.3. The small firms classification

In this case, cluster analysis has been applied to 6,312 small firms. 7 main types have been obtained (fig. 6.2). Not surprisingly, the typology shows a broad similarity to the 'global classification'. Notwithstanding this similarity, it is interesting to single out the variety of innovation patterns that one can find among small firms and to compare their respective economic outcomes.

6.3.1. Description of types of innovative behaviour

The characteristics of types of small firms are broadly similar to those of the corresponding ones in the 'global classification' (see table 6.4).

Fig.6.2 - Types of small firms innovative behaviour



R&D-based clusters

1. R&D-based type

2. R&D-intensive type

3. Occasional R&D based type

Non-R&D-based clusters

4. Industrial design-based type

5. Market-oriented type

6. Investment-based type

7. Licenses-based units

The variety of types of innovating behaviour found among small firms is surprising. The share of firms carrying out R&D (firms in types 1 & 2 are 30.8% of the sample) slightly outnumber that of those which innovated in the most traditional way, that is by introducing embodied innovations (type 6 is 30.1%). However, small 'Schumpeterian' high -tech. firms are very few (type 2 is only 0.1%). The other three major groups are those relying on occasional R&D (type 3, 17.1%), on next-to-the market innovations (type 5, 10.8%) and on industrial design (type 4, 9.3%).

6.3.2. Comparison of the performance of different types of small firms

A comparison between tables 6.2, 6.3, concerning all firms, and table 6.5 reveals that the different types of small firms are more homogenous in terms of employment and economic performance than in the previous exercise concerning the total sample of innovating firms.

The *Design-based* and *Investment-based* types show a good performance in terms of growth rates of employment, hours worked, value-added and exports. On a lesser degree this is true also for the *Market-oriented* type. Interestingly enough, in the case of small firms, investment-based innovative behaviour is not linked to a fall in the use of labour-inputs. This only happen when larger firms are included (as in type 8 of the global clustering). The other types show a positive result in terms of employment but not in terms of hours worked. Difficulties seem to have emerged for the *R&D-intensive* type that shows the largest fall in hours worked.

In terms of export share in total sales (tab.6.6), *R&D-based* and *Design-based* types show the most encouraging results (respectively 28% and 26% against an average of 24%). From the R&D-*based* type come almost half of total exports from this sample (compared to a share of total employment of 38.1%). It also shows the largest growth rate of exports over the period. With the exception of the *R&D-intensive* and License-*based* types, all types show positive growth rate of exports.

The highest share of investment in value-added is shown by the *Investment-based* type.

Tab. 6.4 - Results of cluster analysis on small firms. Values of the variables employed in the analysis.

CLUSTER		Tipology of R&D						
n.	*Definitions*	n.of firms	Average size	Continuous	Occasional	Absent	R&D/sales °/°°	Investment/sales °/°°	Innov.costs/sales °/°°
1	*R&D-based*	29.8	73	100.0	0.0	0.0	31.5	28.8	41.3
2	*R&D-intensive*	1.0	46	81.0	11.1	7.9	290.9	144.5	353.4
3	*Occas. R&D-based*	17.1	51	0.0	100.0	0.0	15.3	39.3	25.2
4	*Design-based*	9.3	54	18.9	6.7	74.4	6.6	41.3	43.6
5	*Market-oriented*	10.8	54	20.7	1.6	77.7	4.9	59.6	35.1
6	*Invest.based*	30.1	47	0.1	0.0	99.9	0.0	86.5	3.7
7	*Licenses-based*	1.9	59	24.2	11.7	64.2	8.9	36.1	38.0
	Total	100 (6312 firms)	57	35.1	18.2	46.7	16.2	54.6	29.8

		Distribution of innovation costs:					Shares of sales:		
		R&D	Licenses	Industrial design	Trial production	Marketing	Not innovatec sales	Process innovations	Product innovations
1	*R&D-based*	56.9	1.6	17.8	17.9	4.7	37.4	21.9	40.8
2	*R&D-intensive*	56.8	2.0	15.4	18.8	5.5	33.3	20.7	46.0
3	*Occas. R&D-based*	48.3	1.8	18.6	23.4	5.3	40.9	26.7	32.5
4	*Design-based*	6.5	1.0	76.5	7.0	2.0	32.7	26.5	40.8
5	*Market-oriented*	4.8	2.1	14.2	56.0	23.0	39.5	29.1	31.4
6	*Invest.based*	3.3	0.5	2.8	2.4	0.5	39.1	43.6	17.4
7	*Licenses-based*	8.7	77.7	5.5	6.9	1.3	40.9	30.9	28.2
	Total	28.0	2.7	18.2	17.1	5.2	38.3	30.6	31.1

Source: Istat, CIS

Tab. 6.5 - Comparison of the emplyment and value added growth rates of different types of Small firms IF. 1989 92

(percentages)

n.	CLUSTER	Annual rates of growth of employment 1990-92	Annual rates of growth of hours worked 1990-92	Annual rates of growth of value-added (in real terms) 1990-92	Annual growth rate of per-capita productivity 1990-92	Annual growth rate of per-hour productivity 1990-92
1	*R&D-based*	1.76	-0.74	5.64	3.87	6.38
2	*R&D-intensive*	1.43	-3.61	3.84	2.41	7.45
3	*Occas. R&D-based*	0.69	-0.71	3.49	2.80	4.20
4	*Design-based*	1.55	0.94	6.33	4.78	5.39
5	*Market-oriented*	1.56	-0.01	3.66	2.09	3.67
6	*Invest.based*	1.06	0.11	4.40	3.34	4.29
7	*Licenses-based*	0.96	-0.81	5.26	4.30	6.07
	Simple average	0.78	-0.59	2.76	1.98	3.35
	Total (1)	2.44	0.63	6.30	3.86	5.67

Note: (1) The total include non-classified firms.

Source: Istat, CIS, SERF

Tab. 6.6 - Comparison of the export and investment performance of different types of small IF. 1989 92

n.	CLUSTER	Exports/ Sales 1989-92	Distribution of exports (column %) 1989-92	Annual growth rates of exports (%) 1990-92	Investment/ value-added (1) 1989-92
1	*R&D-based*	0.28	49.2	9.44	0.12
2	*R&D-intensive*	0.22	0.6	-2.62	0.14
3	*Occas. R&D-based*	0.23	13.4	6.68	0.12
4	*Design-based*	0.26	9.1	6.31	0.12
5	*Market-oriented*	0.22	9.8	7.60	0.13
6	*Invest.based*	0.17	16.8	7.62	0.15
7	*Licenses-based*	0.18	1.1	-5.59	0.11
	Simple average	0.22	-	4.20	0.07
	TOTAL (1)	0.24	100	9.27	0.13

Note: (1) The total includes non-classified firms.

Source: ISTAT, CIS, SERF.

6.3.3. Final comments

The negative results of the small group of 'Schumpeterian' high-tech. firms included in the *R&D-intensive* type should be contrasted to the encouraging performance of this type in the 'global clusters'. The good results obtained in the 'global clusters' should then be attributed to the larger units and not to the small ones. By contrast, three traditional innovation channels based, respectively, on industrial design (type 4), investment (type 6) and next-to-the-market innovations (type 5) have emerged as the best performers. It should be noted that there is a strong complementarity between the design of new machinery carried out in the *design-based* type and its adoption in the *investment-based* type.

To sum up, small firms based on R&D exhibit the poorest performance, whereas more 'traditional' innovation patterns exhibit better results. This is an interesting result, since it suggests that in Italy the difficulties of the R&D-based enterprises do not concern only large firms, but also small firms.

6.4. The impact of innovation variables: results of discriminant analysis

In the previous sections we have identified different types of innovative behaviour. Now, we would like to assess the impact on firms' performance of the innovation variables we have used in cluster analysis. In this section we present the results obtained by using Canonical discriminant analysis. In plain words, firms are divided in two groups, those exhibiting an above-average performance and those presenting a below-average performance. Discriminant analysis shows whether the two groups are statistically distinct also from the point of view of the innovation variables.

Regression analysis has also been carried out, but with unsatisfactory results. With few exceptions, single innovation variables does not show a statistical significant impact on performance. This may depend on many factors, for instance on the functional forms of the relationships, the quality of the variables used in the analysis etc. Not surprisingly, at the present stage of research on CIS data, more explorative techniques, such as cluster and discriminant analyses, have been more successful. More sophisticate regression models may be tried in the future.

6.4.1. Description of the approach

The following *dependent* performance-variable have been selected:
Y_1 = rate of change of employment over the period 1990-92 (n. of employees in 1992/n. of employees in 1989)

Y_2 = rate of change of hours worked over the period 1990-92 (n. of hours worked in 1992/n. of hours worked in 1989)
Y_3 = variations of the 'employment share' of firm i in sector j, 1990-92[12]
Y_4 = variations of the 'hours worked share' of firm i in sector j, 1990-92[13]
Y_5 = variations of the 'export share' of firm i in sector j, 1990-92[14]

The *independent* innovation-variables are those used in cluster analysis:
X_1 = typology of R&D activity (continuos; occasional; absent)[15]
X_2 = R&D/sales in 1992
X_3 = investment on innovated fixed capital/sales in 1992
X_4 = innovation costs/sales in 1992
X_5-X_8 = distribution of innovation costs among R&D; Patent licences; Design; Trial production; Market analysis
X_9-X_{11} = distribution of sales among not innovated products; products innovated only from the point of view of processes; incremental product innovations; major product innovations.
Also firms' size (measured by the number of employees in 1989) has been included as an independent variable (SIZE) as a rough proxy for other factors affecting performance.

Discriminant analysis divides the sample into two groups, one composed of those units that show an above average performance, a second with the units that exhibit a below average performance with respect to each performance-variable (Y_h). Then a linear combination of the explicative variables (X) is calculated that is better correlated to the Y. In plain words, discriminant analysis permits to identify which innovation variables distinguish most between good and poor performers.

On the basis of these Y_h-variables, the variables Z_h have been so defined:

$Z_h > 1$, if $Y_h \geq 0$

$Z_h < 2$, if $Y_h < 0$, $\quad h = 1, ..., 5.$

In simple terms, the new variables Z_h take value 1 when a firm has an above-average performance according to the performance-variable Y_h. It takes value 2 in the opposite case of a below-average performance.

The results are shown in table 6.7.

6.4.2. Simple guidelines to the results

In looking at the results the following guidelines can be helpful. The results are grouped in three complementary sets:

A. UNIVARIATE TEST STATISTICS: this test concerns the existence of statistically significative differences between the average values of the innovation-variables X_k taken in the two groups defined by each Y_h. *A quick look to this table shows which variables discriminate between above and below-average performers.*

B. MULTIVARIATE STATISTICS and EXACT F STATISTICS: These four tests ('Generalised Mahalanobis distance; Maximum joint likelihood; Wilks test; Canonical R^2)[16] concern the overall difference between the two groups on the basis of all the innovation-variables.

C. TOTAL CANONICAL STRUCTURE: it provides the coefficient-values of a discriminant-equation that assign each firm to one of the two groups on the basis of the values of the innovation-variables and of the similarity with the units already in a group. The coefficients vary between -1 and 1. They should interpreted according to this simple rule:

> the higher the *absolute* value taken by a negative X_k, the higher is its association to a *good* performance; the higher the value taken by a positive X_k, the higher is its association to a *bad* performance. For instance, looking at the top, right-hand-side value, 0.69 indicates that size is positively related to a *below-average* employment performance. On the same row, -0.37 suggests that X_{11} (major product innovations) is positively related to an *above-average* employment performance.

6.4.3. Illustration of the results

Canonical-R^2, that measures the (linear) correlation between the Z_h and the X_k variable, is low. Nonetheless, a certain number of innovation-variables discriminate quite well between high and low performers. Firms' size (SIZE) is the most effective influence on all performance-variable.

Looking at the rate of change of hours worked (Z_2) (that we consider as the most reliable indicator of labour input), the variables related to R&D (X_1, X_2 and X_5), innovation costs (X_4) and SIZE show a negative influence.

Tab. 6.7 - Results of canonical discriminant analysis.

Statistical significativity of innovation-variables

Dep.var.s	*UNIVARIATE TEST STATISTICS*											
	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	SIZE
Z1					x			x			xxx	xxxx
Z2	xxxx	xxx		xxxx	xxxx							xxxx
Z3	xxxx				xxxx		xxxx	xx	xxx	xxxx	xxxx	xxxx
Z4	xxxx		xx		xxxx		xx	x		xxxx	xxx	xxxx
Z5	x							xx	xxx	x	xxxx	xxx

Values of the discriminant function (total canonical structure)

Dep.var.s												
	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	SIZE
Z1	0.02	-0.05	0.11	0.21	**0.27**	0.04	-0.14	**0.24**	0.21	-0.06	**-0.37**	**0.69**
Z2	**0.51**	**0.28**	0.06	**0.37**	**0.55**	-0.03	-0.03	0.08	-0.01	0.01	-0.04	**0.79**
Z3	**-0.31**	0.09	0.06	0.05	**-0.32**	-0.07	**0.25**	**0.13**	**-0.16**	**0.46**	**0.31**	**-0.58**
Z4	**0.51**	0.01	**-0.15**	0.01	**0.46**	0.07	**-0.16**	**-0.12**	0.03	**-0.40**	**-0.13**	**0.61**
Z5	**0.28**	0.13	-0.02	-0.09	0.11	0.15	-0.01	**-0.31**	**0.43**	**-0.25**	**-0.57**	**0.42**

MULTIVARIATE STATISTICS			
Wilks	Likelihood ratio	Mahalanobis	Canonical R2
xxxx	xxxx	xxxx	0.06
xxxx	xxxx	xxxx	0.12
xxxx	xxxx	xxxx	0.16
xxxx	xxxx	xxxx	0.15
xxxx	xxxx	xxxx	0.07

LEGENDA	
N.S.	Not signif.
x	0.050<prob.<0.1
xx	0.025<prob.<0.050
xxx	0.001<prob.<0.025
xxxx	prob.<0.001

Source: ISTAT, CIS, SERF.

The 'hours worked share' (Z_4), that indicates the relative expansion or contraction of each firm in its sector, is also negatively affected by two variables related to R&D (X_1 and X_5), but positively by the share of innovative investment on sales (X_3), by the share of cost devoted to Industrial design and Trial production (X_7 and X_8), by the share of incremental and significant product innovations (X_{10} and X_{11}), and by SIZE.

The 'export share' (Z_5), that indicates the relative expansion or contraction of each firm's exports on total exports from its sector, is negatively affected by R&D (X_1), but positively by Trial production (X_8), by product innovations (X_{10} and X_{11}) and by SIZE.

6.4.4. Final comments

The results of Discriminant analysis confirm those obtained in the previous sections and in chapter 5. They show that the employment and export performance of IF is positively affected by non R&D innovation sources, such as Design and Trial Production, and by product innovations. Size is also a very relevant factor which is negatively related to performance.

6.4. Review of the chapter

In this chapter explorative techniques have been adopted to identify different types of innovating firm and to assess the impact of innovation-variables on performance-variables.

In the case of 'global' clustering not many differences have emerged in the employment performance of different types. Most of them just reflect the negative patterns of IF that have already emerged from chapter 5. The positive exceptions are a small, very innovative, type, and a more traditional type oriented towards product development and marketing.

Cluster analysis on small firms show that only a minority of them innovate by acquiring new machinery. Many carry out R&D activities. Many others rely on various internal source of knowledge such as Design, Trial production and Marketing. In the case of small firms, the non R&D based innovation patterns generally exhibit better results.

Discriminant analysis confirmed that non R&D innovation sources and small size are related to above-average employment and export performance.

The better performance shown by the non R&D-based innovation patterns suggests that Italy is able to compete by innovating traditional industrial practices, not suffering much from competition from low-wage countries. The coupling of a good design and prompt diffusion of new machinery is the key to this result. Firms that base their innovations on a close look at markets seems also to perform well. The diffusion of entrepreneurial abilities in large areas of the Centre-North of Italy is also part of the explanation of the good performance of small firms. It is in the R&D-based types that Italy is experiencing the greatest difficulties. This discouraging result concerns both large and small firms.

Footnotes

[1] Many firms did not fill the part of the questionnaire concerning the distribution of innovation costs (that concerns internal sources of innovation). However, most of these firms put a figure on innovation-related investment costs, showing that they were not ignoring the distribution of innovation costs, but that it did not apply to them. For this reason we have implicitly treated the missing values as a variable.

[2] In table 6.1 (and 6.4), for simplicity, var.14 and 15 have been merged. It should also be noted that the distribution of innovation costs is not always 100% because missing values have been considered as a variable (as explained in the previous footnote).

[3] The following sectors are particularly represented in this type: Chemical (54.9% of the firms that belong to this sector belong also to type 1, as against an average of 28.9% from all sectors), Synthetic fibres (53.8%), Industrial machinery (38.1%), Electric, electronics (42.1%, Auto vehicles (38.9), Other transports (35.3%), Scientific instruments (40.3%).

[4] Typical sectors of cluster 2 are Computers (25.8% of firms from this industry are in this type, against an average of 4%), Electric, electronics (10.8%) and Scientific instruments (15.3%).

[5] Many sectors are represented in this type with shares of firms close to the average (which is 15.1%). The sectors with the highest shares are Synthetic fibres (23%), Metal products (19.2%) and Wood & furniture (20.3%).

[6] Also in this case, a large number of sectors are present with shares of firms close to the average (which is 8.9%). The industry with the highest share is Machinery (12.5%).

[7] The sectors with the highest shares are Synthetic fibres (with 15.3% against an average share of 9.8%), Wood & furniture (20.3%), and Other manufacturing (17.4%).

[8] The Computer industry shows the highest share of firms in this type (22.5% against an average of 5.3%). Textiles (12.1%), Leather (9.5%) and Wood & furniture (9.3% show also high shares.

[9] The industries with the highest share of firms in this type are Non metallic mineral mining (60.6% against an average of 25.2%), Metal products (33.4%), Basic food production (35.2%), Food & drinks (34.5%), Textiles (37.6%), Clothing & footwear (40.1%), Paper & printing (46.5%).

[10] The sector with the highest share of firms in this type is Chemical (with 4.1% against an average of 1.8%).

[11] The introduction in this survey of additional innovation sources, such as occasional R&D (type 4 absorbs 15.2% of firm) and trial production, not present in the first Italian innovation survey or merged with design, is likely responsible for the diminished importance of design.

[12] That is:

$$\frac{\text{employment of } F_{ij} \text{ in } 1992}{\text{employment of } S_j \text{ in } 1992} \Big/ \frac{\text{employment of } F_{ij} \text{ in } 1989}{\text{employment of } S_j \text{ in } 1989}$$

, where F_{ij} is firm i in sector j, and S_j is sector j. Figures concerning S_j are taken from SERF.

[13] That is:

$$\frac{\text{worked-hours of } F_{ij} \text{ in } 1992}{\text{worked-hours of } S_j \text{ in } 1992} \Big/ \frac{\text{worked-hours of } F_{ij} \text{ in } 1989}{\text{worked-hours of } S_j \text{ in } 1989}$$

[14] That is:

$$\frac{\text{exports of } F_{ij} \text{ in } 1992}{\text{export of } S_j \text{ in } 1992} \Big/ \frac{\text{export of } F_{ij} \text{ in } 1989}{\text{export of } S_j \text{ in } 1989}$$

[15] This variable has been re-quantified in a continuous variable through multiple correspondence analysis. Its values go now from -1.86 associated to the absence of R&D, 0 is associated to occasional R&D, 1.86 to continuous R&D.

[16] Only the most important tests are reported.

Conclusions

1. The impact of innovation on employment in the Italian experience

The results of the Italian Community Innovation Survey have provided an opportunity to look at the actual impact of innovations on employment at the enterprise level. In pursuing this objective, serious methodological problems have been faced.

To begin with, CIS has not been designed to assess the occupational impact of innovations. We have compensated for this inadequacy by using information from other sources. Unfortunately, the additional information presented some serious shortcomings. In particular, the employment figures are gross of temporary lay-offs and total hours worked concern only blue-collars.

Secondly, CIS regards a limited number of years, 1990-92, perhaps a period too short for measuring the long-run impact of innovation on employment which is, over short periods of time, much affected by the trade cycle. Moreover, the period under consideration is not homogenous since it includes the last part of the expansion of the late eighties and the beginning of the severe recession of the early nineties. However, it might be appropriate to assume that the cycle and economic policies affect all firms to the same degree, so that the net effect of innovations on employment can still be assessed.

Thirdly, the definition of innovating firms is a loose one. This is so because, in principle, non innovating firms and SERF firms may have introduced innovations before 1990-92, a period over which they were actually innovating firms; conversely, innovating firms may have introduced innovations only at the end of the period.

Finally, there must be much caution in drawing conclusions regarding the overall manufacturing sector and the economy as a whole, from data concerning a sample of manufacturing enterprises. With regard to the manufacturing sector, encouraging results for, say, innovating firms may have been obtained by displacing less innovating firms. With respect to the economy as a whole, negative employment outcomes in innovating firms may be associated to positive output growth and indirect job creation in the service sector generated by, say, the higher effective demand that results from higher manufacturing exports. These issues have been dealt in part I (in particular in Ch. 4).

Over the period here considered (1990-1992), the employment and output performance of innovating firms does not look better than that of two control groups. The exception

are the small innovating firms. This is in line with similar results obtained by other investigations.

The structure of the Italian manufacturing exports shows a polarisation between large, R&D-based companies and small, traditional firms, with small innovating firms playing a secondary role[1]. The export results of innovating firms indicates positive employment effects of innovations, directly on innovating firms, and indirectly on the economy by raising effective demand and the relaxation of the balance of payment constraint. However, the results of regression analysis suggests that, although the aggregate effects of innovation of export growth is positive, it is not statistically significant at the firm level (although the sign of the regression coefficient is still positive).

Innovating firms display a relatively higher propensity to invest. Investment has also grown in innovating firms at a higher rate than in the control groups. This may lend some support to the idea that over the cycle 'autonomous investment' (linked to technical change), being less dependent on demand, may act as a 'stabiliser'. However, it is possible that more investment by innovating firms has resulted in less investment by less competitive firms. In addition, it is far from clear whether in the long run autonomous investment is a sufficient source of growth. In any event, investment by innovating firms has also been severely hit by the approaching recession caused by the deflationary policies in Italy and abroad.

When classified according to the characteristics of the innovation variables, most of the different types of innovating firms, particularly those based on R&D as the main innovation source, follow the general downward trend in the use of labour-inputs. The special classification carried out on small firms shows that, in the Italian experience over the period covered by CIS, the best performers in terms of employment and other economic variables were those that innovated along traditional lines, such as the acquisition of new machinery, design, trial production and marketing. Also, discriminant analysis showed that non R&D-based innovation patterns, product innovations and small size are related to above-average employment and export outcomes.

All in all, has innovation positively affected employment in the Italian experience over the period 1990-92?

Looking at the direct effects on innovating firms, the answer is no, with the circumscribed exception of small firms. However, from this it cannot be concluded that innovation affected employment negatively, since we do not know what would have happened had those firms not innovated. The very fact that the best employment and

economic results have been found among those firms that follow the most traditional innovation patterns, may indicate that in the Italian experience those following the less traditional innovation patterns (that are generally based on continuous R&D activities) were not sufficiently effective. This has resulted in dismal sales growth to the advantage of foreign competitors (likely ore in the domestic market), so that the negative impact of process innovations has not been compensated by output growth at firm level. The more positive experience of a small group of firms exhibiting a very high financial commitment to R&D may show that a bigger effort is rewarded by high growth at enterprise level.

The indirect effects of innovations through exports and investment look more encouraging. However, it must be noted that also in this case the most traditional innovation patterns were the most successful.

2. The long period framework and policy issues in the Italian context

To put these outcomes in perspective, our results show the continuation of a tendency towards the deterioration of the role of the large, R&D-based companies in Italy. Our results reveal that also small R&D-based firms show worse results compared to non R&D-based small innovating firms. The problems met by large firms are common to other European and OECD countries. However, in Italy the decreasing role of large firms and the emerging role of small firms has earlier origins in the seventies.

In those years, the difficult industrial relations in big firms and the floating exchange rate policy encouraged the development of the small business sector whose competitive advantages were mainly based on cost (De Cecco, 1994). Large-scale industry only rationalised production in the eighties, once industrial relations became more favourable to entrepreneurs with a weaker resistance of workers to massive dismissals. Yet, the restructuring and the recovery of profitability in the eighties was not accompanied by the development of R&D-based activities. In terms of job creation, the small business sector was still the most vigorous, whereas the employment decline of the large enterprise sector has been continuous (Barca, Magnani, 1989).

The participation of Italy in the EMS from 1979 was justified during the eighties, *inter alia*, as an industrial policy oriented to stimulate the introduction of innovations in the manufacturing sector (firms could not rely any more on devaluation to meet increasing wage costs and foreign competition). This policy is not generally considered a success. Anyway, it did not favour a change in the product specialisation of Italy. Moreover, in an economy based on cost competitiveness, the over-evaluation of the Italian lira may have favoured domestic de-industrialisation by increasing import penetration and

decentralisation of production in low-wage countries[2]. The deterioration of the trade balance in the late eighties reinforced these negative views.

The years 1990-92 were of severe international recession (delayed, but more prolonged in Continental Europe). Domestic factors such as the progressive revaluation of the Italian lira in real terms with the consequent loss of export competitiveness, the restrictive fiscal policies and the decline in public works due to the discovery of widespread corruption made the situation in Italy worse. Our data show that small firms have continued to be the most successful under the difficult circumstances. Innovating firms were able to expand exports more than the other groups. Within them, those following the most traditional innovation patterns were the most effective.

The devaluation of the Italian lira in September 1992 marks a significant change. In the last few years Italian exports have been the only growing component of effective demand (visible exports grew 9.1% and 10.9% in 1993 and 1994, respectively). Only late has investment begun to recover. Commentators suggest that traditional sectors are those that have mainly taken advantage of the recovered price competitiveness.

In term of industrial policy, our results re-propose the old dilemma whether and for how long can Italy successfully pursue her peculiar model of being innovative in traditional sectors, and what dangers may arise in the long run from lagging behind in R&D-based industries and from the decline of large firms. On the one side this model should not be opposed, as far as it goes (and it has already gone very far). On the other side there are not clear cut policies to improve the Italian competitiveness in R&D-based productions. Italian firms look interested in the co-operation with universities, perhaps more than they wish to take the risk of long-period *in-house* R&D (Cesaratto, Stirati, 1995). They should be encouraged to invest in *intra-muros* research, providing good employment perspectives and R&D facilities to young Italian researchers. In addition, it should not be forgotten that in Italy most of the high-tech. companies belong to the public sector, and that for many years (especially in the fifties) they have been competently managed and contributed to the technological development of the country. A rapid privatisation or lack of support to these companies may lead to the disappearance of many high-tech sectors in Italy. Of course, any solution should aim at the long-period efficiency of these firms.

3. The policy issues in the European context

The essential theoretical and methodological feature of this report lies in taking what could be called an Effective demand approach to study the long run impact of technical change on employment.

Given that, in our view, Effective demand determines the rate of growth of the economy, it is clear that the rate of growth of employment will depend on the difference between the growth of effective demand and the rate of growth of labour productivity. Was the very slow rate of job creation in Europe in the eighties and nineties the result of an abnormally high growth of labour productivity or of an excessively slow growth of aggregate demand?

Despite all the talk of a 'third industrial revolution' and a wave of technological unemployment, the data show that the growth of labour productivity in Europe was not particularly high (it was certainly lower than in the fifties and sixties, see Ch.3). Yet the rate of growth of employment has been very low or even negative (depending on the period one choose and on how you define Europe). Therefore it seems that the answer to this second question is that aggregate demand did grow at a very slow pace.

It is possible that in Europe technical change has not been particularly favourable to demand growth, for it seems that there has been a concentration on process innovations (that tend to destroy jobs) at the expense of product innovations (that favour job creation).

However, this conclusion must be qualified, for technical change does not occur in a vacuum. For instance, for process innovations to shift income permanently from wage earners it is required that real wages lag behind productivity growth. That seems to have occurred in Europe during this period, but that has been a result of complex political and economic forces, not of technical change as such. Concerning the alleged slow rate of product innovations, it is possible, for example, that faster and more radical changes in consumption patterns, and less concentration on process innovations, could have been observed had monetary policy and hence consumer credit conditions been looser over the period.

These remarks lead us to what we believe is the central problem concerning technical change and employment in Europe. The point is that technical change, particularly if concentrated on process innovations, will tend to destroy jobs if the macroeconomic policy stance regarding fiscal, monetary, exchange rate and income policy has a deflationary bias. This bias has been accentuated as a consequence of the criteria adopted by the EU for member countries to qualify as part of the process of monetary unification. These criteria have become object of public concern in the EU.[3] At least from the point of view of Europe, while technical change as such may not help job creation, it cannot be considered the main source of the increase of unemployment.

In addition, for any European country and for the EU as a whole, innovation is beneficial in terms of competitiveness in foreign markets. Therefore innovation is welcome and not to blame. However, much attention should be paid to avoid empty formulas. Taking Europe as a closed market, a general increase of competitiveness (whatever this means) is a zero sum game. For a single economy or economic integrated area (such as the EU), greater efficiency can only lead to output and employment growth if it leads to greater exports outside its boundaries. Within a single integrated area, a greater competitiveness of a single country can lead to employment and output losses for other countries. Accordingly, the positive impact of innovation on exports in Italy over 1990-92 has to be seen, at least to a degree, as advantageous only from her point of view. Europe as a whole, would benefit from a better export performance of a single country only for that part of exports that go to extra-European countries.

In terms of European industrial policy, the objective of faster technical change in the Union should be accompanied by measures aimed at having a balanced distribution and diffusion of technological capabilities all around Europe. However, it would be wrong to assign to the diffusion of innovation in Europe the objective of full employment. The latter requires that a suitable set of macro-economic policies returns on the agenda of European governments.

Footnotes

[1] The delay in the availability of data for our panels for the period subsequent to the devaluation of the Italian lira in September 1992 has prevented the planned assessment of the impact of this major event on the export performance of the various classes of firms.

[2] No adjustment of the Italian lira within the EMS took place from 1987 till September 1992. The indirect effects of EMS have certainly been harmful by determining, jointly to the liberalisation of international capital flows, higher domestic interest rates that, in turn, increased the cost of the public debt determining, later, restrictive fiscal policies.

[3] It is doubtful that the participation of Italy to a new exchange rate mechanism designed for those countries that are excluded from the process of monetary unification will be advantageous. Indeed, Italy may incur again in the disadvantages of fixed exchange rates without the benefit of a common currency.

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APPENDIXES

Appendix 1

A simple model of long period Effective demand

Useful to fix ideas about the determination of the long-period level of capacity through the autonomous components of aggregate demand is Hicks' concept of the supermultiplier (Hicks, 1950; Kaldor, 1970; Serrano, 1995, 1996).

Equations from [1] to [8] are based on the well-know Keynesian model for the determination of the (gross) national income. The (gross) investment level (equation [4]) is a function of the expected rate of growth of demand. Government expenditure (G), autonomous investment (I^A) and exports are the autonomous components of effective demand (X).

[1] $Y = C+I+G+X-M$

[2] $C = c(Y-tY)$

[3] $T = tY$

[4] $I = a\Delta Y$ [where $\Delta Y = Y_{+1}-Y$]

[5] $G = G_0$

[6] $X = X_0$

[7] $I^A = I_0^A$

[8] $M = mY$

From them the expression for the supermultiplier can be easily derived:

[9] $$Y = \frac{G_0 + I_0^A + X_0}{1 - c(1-t) - m - ag_Z}$$

In writing equation [9] we assume that entrepreneurs expect aggregate demand to grow at the same rate as the autonomous component of effective demand ($Z = G_0 + I_0^A + X_0$) that is

$$g_y = \frac{\Delta Y}{Y} = g_z$$

The supermultiplier tells us the level of equilibrium output capacity as a function of the levels and rates of growth of the autonomous components of effective demand. On the basis of this model, the verbal argument of § 2.3 can so be restated:

(i) *product innovations* increase the marginal propensity to consume (c) and lower the import coefficient (m), therefore increasing the amount of capacity generated by given patterns of the autonomous components of aggregate demand. In addition they may positively affect I_0^A (may inducing early economic obsolescence of declining products) and X_0 (by making exports more competitive).

(ii) *process innovations* may increase I_0^A (by inducing early replacement of plants) and X_0 (by making exports more competitive). They may affect c (making consumer goods more accessible) and m (by making domestic products cheaper). Finally, process innovation may affect the capital/output coefficient (a), but not in a predictable way.

Appendix 2

Innovation and autonomous investment

1. The Schumpeterian thesis

According to the Schumpeterian economists technological unemployment is a short period phenomenon in two senses:

(a) Albeit with little agreement as to the causes and timing of innovation clusters,[1] these economists argue that innovations tend to concentrate over specific periods of time. The periodic scarcity of innovations, in particular the lack of major product innovations, is what determines cyclical unemployment. In the long run innovations set the trend of economic growth.

(b) During an economic upsurge due to major innovations, unemployment may rise because of process innovations (that accompany the mass diffusion of product innovations) and structural change in the composition of jobs. However, technological unemployment - so this influential argument goes - is compensated by higher levels both of induced and autonomous consumption and of induced and autonomous gross investment, all stimulated by the innovations, so that the higher social output leads to the recovery, partially at least, of the lost jobs.

We fully agree that major product innovation can, given the host of additional circumstances mentioned in § 2.3, stimulate the induced and autonomous consumption, and through this channel, induced investment. More controversial are the effects of technical change on *autonomous* investment. This aspect is very influential on the discussion on the impact of innovations on employment. It is also quite relevant for the

applied work presented in the second part of this report. In this section we focus on technical change as a determinant of autonomous investment.

2. Effects of innovations on composition and level of investment

We may distinguish between *composition* and *level* effects of innovations on gross investment. Dealing with the composition effects, we assume that the rate of growth of Effective demand is exogenously given. Dealing with the level effects, we take into account the impact of autonomous investment decisions on the rate of growth of Effective demand (that becomes now partially endogenous).

2.1. Composition effects of innovations on gross investment

In a capitalistic economy profit is the sole motivation for production. Therefore, it makes sense to assume that firms will want to produce only what they can sell profitably. The quantity that firms would like to produce in a given period is thus equal to the amount that they would be able to sell at prices which allow them to obtain the normally accepted (or required) standard of profitability (or normal rate of profit).[2]

The Prices of Production, or Normal prices, calculated taking into account the normal wage costs, the dominant techniques and the normal rate of profit, are precisely the prices which incorporate these profitability requirements. If Effective demand is defined, as it should be, as the demand forthcoming at these Normal Prices, then it follows that the firms' (desired) level of output will be determined (and equal to) the level of Effective demand. This being so, the size of the productive capacity that they would like to have available in a given period will naturally also be that one which allows them to produce the amount of output sufficient to meet (Effective) demand. This is true in aggregate, for each sector and for each firm: in the long-period productive capacity is determined by the quantity that producers expect to sell at the Normal Prices of Production[3].

The expectation of *persistently* higher levels of Effective demand is the sole explanation of decisions to extend productive capacity. For the single firm, productive capacity is determined, given the growth rate of Effective Demand for the products of its sector, by its expectations as to the *share* of demand it expects to satisfy yielding a normal profit rate.

Given the overall rate of growth of *Effective demand* (whose determination has been illustrated in § 2.2), innovative industries may grow at a rate higher than average. This because it can be argued that the composition of demand is changing in favour of innovative products. Correspondingly, however, less innovative industries would show

a below-average growth. The net effect of technical change on the *level* of gross investment is therefore, in general, nil, since the higher growth of gross investment in the innovative sectors is compensated by the lower rate in the less innovative industries.[4] Similarly, given the growth rate of demand for the products of a single industry, the most innovative firms in that industry may generally grow faster than the less innovative. But also in this case the net effect on the *level* of gross investment is, in general, nil.

It may be concluded that the mere existence of innovative sectors or innovating firms does not lead to a higher rate of gross investment, although it changes its *composition.* (Note that also the impact on job creation will be in general nil, the new jobs - if any - created by the innovators being matched by the lost jobs by the less-innovative).

2.2. Level effects of innovations on gross investment

Technical change may induce in competing firms, most likely in innovative industries, a level of (autonomous) gross investment higher than that otherwise justified by the given patterns of Effective demand. In turn the higher (autonomous) gross investment would positively affect Effective demand. More precisely, 'Schumpeterian competition' would show itself in two forms:

(A) in the innovative sectors the expectation of a larger *market share* by a substantial number of competing innovating firms can lead to a level of (autonomous) gross investment higher than that justified by the (initially given) rate of growth of Effective demand (leading, therefore, to an initial excess of capacity in the sector);

(B) the competitive process can lead in sectors subject to technical change to the *early replacement* of capital goods, also causing a higher level of gross investment[5]. This early scrapping can also take place between industries through the establishment of new industrial sectors (characterised by new products) accompanied by the decline of old sectors (Garegnani, 1962, p.96).

(C) as a result either of (A) (the attempt to subtract market shares from competitors) and/or (B) (early replacement), technological competition increases autonomous gross investment and, as a consequence, Effective demand. The rise of aggregate demand can, at least partially, justify the initial excess of capacity set out by (A).

2.3. The effects on innovations on autonomous investment are possible but not necessary

So far so good. But how likely is that 'Schumpeterian competition' can sustain long-period growth of demand and of employment through the effects of innovations on (autonomous) gross investment?

The first objection concerns the *persistency* of the effect of technological competition on gross investment. Let us start from the channel (B). A process of widespread early replacement in a sector can be matched by subsequent periods of lower gross investment, unless further technical change is in view. Also in case (A), although excess capacity can initially be partially matched by higher Effective demand (itself a result of the higher autonomous gross investment), the process of adjustment of capacity cannot but lead to a fall of gross investment in the subsequent periods. Technical change may take place in other sectors, but this is, again, a matter of history, not a *logical* necessity.

The effects of technical change on gross investment seem therefore to lack the persistency and pervasiveness necessary to assure a long-period *growth* of Effective demand and a stable level of full employment, even as an average over very long periods of time.[6] And indeed, Schumpeterian economists are never clear as to why innovations cycles should establish a trend rather than just a cycle around a trend to be explained by other factors. Indeed, as the results presented in Ch. 5 show over the period 1990-92, investment related to innovations is higher in innovating firms both during the expansion and the recession. However, the trend seems to reflect that of the economy as a whole.

Secondly, the expected shortening in the economic life of capital goods as a consequence of a faster technical change can lead to *capital-saving innovations* (Caminati, 1985),[7] or to the *postponement* of investment (Rosenberg, 1976). In the first case the higher autonomous investment determined by early replacement is compensated by the lower value of the new capital goods. In the second case, replacement is postponed (as long as the firm can remain in the market using the obsolete technique) until technology has settled.

Finally, the existence of *indivisibilities* in the application of new *process* technologies and the importance of the rate of growth of per-capita income in inducing *product* innovations, suggest even a reversal of the causation between demand growth and innovation (Schmookler, 1966). Expectations of demand growth may induce fiercer

competition among firms, since the larger market reduces the barriers to entry and increases the likelihood of survival by product differentiation.[8]

It can be concluded that the existence of positive compensation effects to technological unemployment on the demand side through (autonomous) gross investment while possible, are not a necessary result. This is not to deny that autonomous investment may play an important role in the explanation of economic cycles and, in particular, soften the impact on employment of falling rates of growth of Effective demand (see Ch.5).[9]

Footnotes

[1] According to Schumpeterian economists innovations tend to appear in 'swarms', thus explaining the alternation of phases of rapid growth and phases of stagnation. Their timing is attributed to different causes such as the scarcity of *entrepreneurial capacity*, as in the original Schumpeterian theory, or the *discontinuity of technical progress*, the prevailing explanation after Kuznets' (1940) criticism. The causes of this discontinuity are still controversial (see the contributions in Freeman, 1983). On the one side Mensch, Kleinknecht and others argue that it is the hardship of economic depression that stimulates the search for major product innovations giving place to new phases of prosperity, followed, in the expansionary phase, by incremental and process innovations. On the other side economists at SPRU, University of Sussex, argue that an expansionary macro-environment favours the technological application of independent scientific progress, which is however assigned the leading role in the accumulation process.

[2] 'The criterion for investment in a competitive industry is the expectation of a flow of surpluses between revenue and current operation costs which, over the life of the investment, are sufficient to recover the principal of the investment and earn a normal rate of return' (Salter, 1966, p.55)

[3] Since Normal profitability includes a normal degree of capacity utilisation, the proposition can be restated by saying that the long-period productive capacity is determined by the quantity that producers expect to sell at a normal degree of capacity utilisation. The normal degree of capacity utilisation is generally below the technical maximum feasible degree since firms would usually like to have some spare capacity to meet, say, unexpected peaks of demand.

[4] It can be positive if the growing sectors show a higher capital/output ratio. But it can be as well negative if the opposite case is true.

[5] "Whatever may be its effect on net investment, technical progress will normally raise gross investment, in so far as it hasten obsolescence and shortens the life of existing capital" (Matthews, 1959, p.68, quoted by Caminati, 1986). It can be shown that a shift to capital equipment of a shorter life span will *ceteris paribus* have the same effect as an increase in the capital-output ratio. The Long Period level of investment will then increase since now more gross investment is needed for any given level of (expected or actual) Effective demand. So a rapid technical change, by shrinking the economic lifetime of fixed capital equipment does have a direct impact on investment.

[6] Pasinetti's (1981) model is precisely the description of an economy at full employment in which technical progress is such that the economy grows in equilibrium. However, the realism of this approach may be questioned.

[7] "Even when the prevailing empirical circumstances are such that a higher rate of embodied technical progress has the effect of shortening the [economic] life of machinery, an increase in gross investment does not follow of necessity. To the extent that the shortening of equipment life is foreseen it may induce capitalists to adopt fixed capital-saving methods of production" (Caminati, 1986). Caminati provides other reasons why the effects of technical change on gross investment could be negative. For instance, the change in relative price brought about by the innovation in one sector might *in principle* determine *in other sectors*

the delay rather than the anticipation of the scrapping of machinery. Also in this case the author concludes that "the proposition that embodied technical change fosters earlier scrapping of machinery is far from being general" (p.125).

[8] See Sylos-Labini (1969). The role of the market size in inducing further competition and divisions of labour was suggested by Adam Smith: "The increase of demand, besides though in the beginning it may sometimes raise the price of goods, never fails to lower it in the long-run. It encourages production, and thereby increases the competition of the producers, who, in order to undersell one another, have recourse to new division of labour and new improvements of art, which might never otherwise have been thought of" (Smith, 1976 [1776], p.748; see Cesaratto 1996a).

[9] To be sure, Schumpeterian economists are never clear as to why innovations cycles should establish a trend rather than just a cycle around a trend to be explained by other factors.

Appendix 3

Methodological issues

Two groups of methodological problems have been met :

(1) inadequacy of CIS for the problem in hand;

(2) inadequacies of the data bases and panel data.

1. Inadequacy of the CIS data

1.1. Lack of information on employment

CIS has not been designed to assess the impact of innovations on employment. The following 'information gaps' should be noted:

(i) Information on the evolution of employment (number of employees, temporary lay-offs, number of effective worked hours) are absent in the questionnaire.

(ii) Information on the structure of employment is also absent (sex, skills, part-time vs. full-time, etc.).

The only question concerning employment has to be found in section VI (Factors hampering innovation) and concerns the difficulty possibly met in finding skilled personnel. This is a limited information and, moreover, consists of an "opinion" and it is not a quantitative, objective figure.

In addition, economic information is limited to Total sales and Exports for the years of the Survey.

Clearly, survey designers expected some of this information to be available from other statistical sources. This is likely the case of the Italian Istituto Nazionale di Statistica (ISTAT).

To have all the relevant information from the Innovation Survey would facilitate the empirical work, although it makes sense for Statistical institutes not to bother firms with information they already possess. In addition, data from different surveys, since different persons may fill the questionnaires in the same company, may provide different information[1]. Information from long established survey is probably more reliable than that from new surveys.

1.2. Missing data in the Italian CIS

An additional problem concerns missing data. ISTAT has not done any work to fill the gaps. An imputation work has been done by us limited to the questions of our direct concern and to those firms that presented minor information gaps[2].

1.3. Additional sources of information on employment and other financial variables

The additional source used to integrate the information on employment and other financial information has been a panel of about 27,000 firms included in the *Indagine sui conti economici delle imprese con piu' di 20 addetti* (Survey on the economic results of firm with more than 20 employees, SERF). Firms surveyed by SERF include those that took part to CIS so that information could be integrated at enterprise level.

From the SERF we obtained information on employment and on other economic variables.

In particular:

(a) number of employees registered in the companies' pay-roll (annual average of the number of employees at the end of each month of the year). This figure is *gross* of the employees temporarily laid-off (Cassa integrazione guadagni), and *this is a serious shortcoming since in the trade cycle actual employment may vary a lot as a consequence of lay-offs* (see appendix 4).

(b) number of hours effectively worked by blue-collars. This information partially compensated the shortcomings of (a), although is limited to blue collars.

(c) number of employees subdivided in white and blue-collars, and sex. This is the only information on the *structure* of employment.

2. Various inadequacies of the data bases

2.1. Coverage discontinuities

SERF covered (in 1990) about 32,500 firms with over 20 employees, most of which collaborated directly to the survey. In principle SERF should cover all Italian firms with more than 20 employees. However, there are serious gaps in the number of firms surveyed by SERF.

In the years concerned the number of firms diminishes of 1,200 units in 1990, and increases of 4,000 units between 1992. The last variation, we have eventually been told by Istat experts, is due to an integration of the data base that followed the results of the national Census (data for these additional units has been estimated). As a consequence, we have decided to work with a set of data consisting of over 26,000 units for which information was available with continuity since 1989.

In addition, although, in principle, SERF should provide information for all firms included in CIS, this information is actually available only for part of the firms, and with temporal discontinuities. Also in this case we decided to work with the set of IF and NIF for which information was available for all the years 1990-92. This reduced the number of firms to, respectively, 5,962 and 9,534 firms.

2.2. Delays in the availability of data

Due to time delays in the availability of SERF figure for 1993, the research team failed to meet one research target, that is how the devaluation of the Italian lira in September 1992 has changed the impact of innovation on Italian export.

2.3. Additional problems with the data sets

Once decided to work with a fixed number of units from SERF and from CIS, those for which information is available with continuity over the period 1990-92, two further 'turbulences' in the data deserve careful attention. The first concerns the changes over the period of dimensional and industrial classes firms belong to. The second regards a significant process of corporate transformations involving a significant number of units.

2.4. Inter-sectoral and inter-dimensional shifts

Many firms are multiproduct firms and over a period may change the sector they belong to. In principle, this is defined on the basis of the main activity that, of course, may change. One cause of this change can be technical change that induces variations in the product mix. An additional important cause are the corporate transformations discussed below. In addition, changes in the number of employees (determined by the economic cycle, by technical change and by corporate transformations) may shift firms from a class of employees to another.

There is actually a relative 'stability' in the number of firms in each class, both in CIS and in SERF. For instance, in the period 1990-92 the number of small IF diminishes of only 30 units (over 5 thousand small firms are included in the Italian CIS). The similar figure for SERF is 25 units. In the analysis, however, we have noticed that these small changes may have a visible impact on the aggregate results.

The best (and workable) solution we envisaged to this problem has been to assign firms of our panels to the sectoral and dimensional class they belonged to in a base-year (the obvious choice was the first year, 1989).

2.5. Corporate transformations

ISTAT experts estimate that the number of formal or substantial transformations in the legal status of surveyed firms is a very relevant phenomenon. Transformations consist of mergers and separations that may concern a part or the whole of one or more companies. The box shows a taxonomy of corporate transformations proposed by Istat (1995, p.75).

a) Sell of activities
- Discontinuance of a firm that hands over the activity to another company
- Partial sell of activities to other companies
b) Acquisition of activities
- Birth of a new firm by the acquisition of an activity from an existing firm
- Modification of an existing firm by the acquisition of other activities

Over the years 1989-1993 Istat has recorded about 3,800 episodes of corporate transformation in the manufacturing sector, about 10% of the total number of firms. Most of the largest companies have been involved in corporate transformations, mainly consisting of the acquisition of smaller firms. Smaller companies tend indeed to sell activities. Modern rather than traditional sectors are more likely to be involved in the transformations.

Two experts of the problem have recently concluded that:

"It is clear that in any micro-econometric investigation on large firms strong risks are taken of bad specifications, and the relative consequences cannot be assessed a priori, given the scarce systematicity of the knowledge on the phenomena of mergers, acquisitions, transfers" (Contini, Monducci, 1995, p.7; see also Barca, Magnani, 1989, Ch.4, appendix 1)[3].

Unfortunately, there is little that we can do to solve this problem that constitutes a serious limitation for the empirical results. For instance, corporate transformation determines the shifts mentioned above in § 2.1. To give another example, some IF may have changed the number of employees just because it merged with another firm.

2.6. Problems with panel data

On the one side, there is a loss of information by working with closed panels, since firms' births and deaths are not taken into account, and they are, of course, an important circumstance affecting jobs creation and destruction. On the other side, CIS data

concern a closed panel of firms, so that it made sense to compare it to similar closed panels of firms.

Footnotes

[1] This is the case for the Italian CIS with regard to information concerning sales and exports.

[2] The method employed to fill the gap simply consisted of replacing the missing figures with the average values of firms of similar size and sector. Few firms whose questionnaires presented too many missing values have been erased from our sample.

[3] The economic explanation of corporate transformations may lay in structural change (processes of vertical and horizontal integrations/disintegrations), but also, likely, in the characteristics of the Italian corporate system. Small firms tend to grow, for instance, by creating new firms. Divisions in large Italian multi-divisional firms tend to be independent legal units, so that organizative changes may take the form of corporate transformations.

Appendix 4

The divergence between the variations of employment and hours worked

The figures presented in chapter 5 show a divergence between the average growth rates of employment and hours worked. While hours worked fall in each year, employment rises (or falls more moderately) in 1990 and 1991. The divergence is more marked for IF (with the exception of small IF).

The two indicators refer, respectively, to total employees (i.e. both white and blue collars) gross of temporary lay-offs, and to hours worked of blue collars. The first indicator tends to smooth the actual variations of employment. The second indicator, since it includes over-time, it is only a proxy of the variation in the number of blue collars, and tends to vary more than the latter over the cycle

Table A3 shows the Spearman correlation coefficients between the rates of change of some variables over the period 1990-92 for three size classes for IF and SERF. In spite of the divergence in the averages shown in the tables, the correlation between changes in employment and hours worked is positive, high and statistically significant in all classes. Both indicators are also highly correlated with variations of value added. Hence we find confirmation of the expectation that at firm level employment and hours worked (and, to a lesser extent due to the possibility of labour saving technical change, also value added) should all tend to move in the same direction, and that the ranking of the size of the changes in these variables should also be correlated.

Tab. A3 - Spearman correlation coefficient between the rates of change of employment, worked hours and value-added

	INNOVATING FIRMS					SERF				
	20-199 employees					20-199 employees				
	EMPL.	HOURS WORK.	WHITE-COLL.	BLUE-COLL.	VALUE-ADDED	EMPL.	HOURS WORK.	WHITE-COLL.	BLUE-COLL.	VALUE-ADDED
EMPL.	1.00					1				
WORK.HOURS	0.59	1.00				0.52	1			
WHITE-COLL.	0.45	0.05	1.00			0.33	-0.07	1		
BLUE-COLL.	0.80	0.71	0.03	1.00		0.75	0.68	-0.15	1	
VALUE-ADDED	0.50	0.38	0.35	0.35	1.00	0.41	0.3	0.34	0.22	1
	200-499 employees					200-499 employees				
	EMPL.	HOURS WORK.	WHITE-COLL.	BLUE-COLL.	VALUE-ADDED	EMPL.	HOURS WORK.	WHITE-COLL.	BLUE-COLL.	VALUE-ADDED
EMPL.	1.00					1				
'VORK.HOURS	0 73	1.00				0.69	1			
WHITE-COLL.	0.63	0.29	1.00			0.56	0.21	1		
BLUE-COLL.	0.85	0.82	0.29	1.00		0.83	0.8	0.18	1	
VALUE-ADDED	0.56	0.54	0.37	0.47	1.00	0.49	0.44	0.37	0.37	1
	Over 500 employees					Over 500 employees				
	EMPL.	HOURS WORK.	WHITE-COLL.	BLUE-COLL.	VALUE-ADDED	EMPL.	HOURS WORK.	WHITE-COLL.	BLUE-COLL.	VALUE-ADDED
EMPL.	1.00					1				
WORK.HOURS	0.76	1.00				0.71	1			
WHITE-COLL.	0.77	0.50	1.00			0.77	0.45	1		
BLUE-COLL.	0.83	0.84	0.46	1.00		0.82	0.81	0.45	1	
VALUE-ADDED	0.54	0.48	0.49	0.40	1.00	0.55	0.45	0.51	0.38	1

Note: All the coefficients are statistically significant at a level of 0.01%.

Source: ISTAT, CIS, SERF.

It remains to be explained why, when we look at the averages in the tables, we find a divergence between changes in hours worked and employment. More specifically, we must explain why the data indicate a better performance of employment with respect to hours worked, especially in the first two years.

The years we observe are the end of an expansion and the beginning of a recession (the through of which is in 1993). In such a phase the firms that are still expanding their employment are likely to do so mostly by new hirings (having already re-employed laid-off workers and stretched working times in the earlier phase of the expansion). By contrast the firms that are beginning to contract are more likely to do so by reductions in over-time and lay-offs, thereby reducing total hours worked. Whereas the increase in employment through new hirings and the reduction in worked hours are visible on our data, lay-offs are not. In 1992, the figures are not divergent, as with the deepening of the economic recession expanding firms become rare, while contracting firms begin to reduce labour inputs not so much *via* further reductions in over-time and temporary lay-offs but, increasingly, by making workers (some of whom previously laid off) redundant.[1]

A second factor that contributes to explaining the divergence between hours worked and employment is the changing composition of the labour force in favour of white-collar workers. This is shown by results discussed in § 5.3, according to which in IF and SERF the share of white-collars on the total labour-force has increased by about 1.5% over the period 1989-1992, and in a lesser measure (0.7%) in NIF. This may be due to the fact that employment of blue-collar workers tend to change more over the cycle, or to structural change in the composition of the labour force - most probably to a combination of the two.

Because data on employment are gross of lay-offs and hence tend to 'hide' changes in actual employment we regard hours worked as a better indicator of variations in labour inputs. However, one may wonder if hours worked may be indeed regarded as a proxy for changes in employment, when we consider that they (a) do not include white collars' worked hours and (b) they include over-time - hence their changes may not reflect changes in actual employment of blue-collar workers. To discuss these problems let us look again at table A3, which shows the Spearman correlation coefficients between the variables we are concerned with.

Let us deal with question (b) first. Evidently, hours worked tend to change more than employment. However the correlation between worked hours and employment of blue-collar workers is positive and high both for IF and SERF.

Concerning question (a), the main problem would be the existence of some systematic tendency for employment of white and blue-collar workers to move in opposite direction. This might happen for example as a consequence of a systematic tendency for innovation in this period to bring about an increase in white-collar employees at the same time as a fall in employment of blue-collar workers. Let us look at the correlation between employment of white and blue-collar workers in IF first. The coefficient is always positive, is very low for small firms and increases with size. The pattern is similar for SERF but the coefficient has a negative sign as well as a very low value for the class of small firms. The correlation coefficient between hours worked and white-collar employment follows a similar pattern in both groups of firms.

The very low correlation coefficient for small IF that become negative in the case of small firms included in SERF, can be explained by the existence of 'indivisibilities' in the white-collar staff in this class (and, to a lesser extent, in the medium size class), due to its small size. These indivisibilities prevent it from changing proportionally to changes in value added or blue-collar employment. In addition, as white-collar employment is a relatively low proportion of total employment in small firms, the lack of correlation between white and blue-collar employment and hence between the former and hours worked in this class of firms does not appear to represent a major drawback for our use of the latter as the main indicator of changes in employment. Finally, the substitution process of white to blue collar workers would take place in opposite directions in small If and in small SERF firms, since in the former (blue-collars') hours worked were increasing, whereas in the latter they were falling. Therefore, it seems difficult to attribute the low or negative correlation coefficient for small firms to any systematic pattern of 'substitution' of white for blue-collar workers.

Finally, our choice of hours worked as the best indicator is also supported by the fact that variations in hours worked are closer to the variations in the standard units of labour (or equivalent full time number of all dependent employees) in the entire manufacturing sector (i.e. including firms with less than 20 employees) in the period, as it results from the National Accounts (see bottom of tables 5.2 and 5.3).

Footnotes

[1] This account finds support in the authoritative *Annual Reports* of the Banca d'Italia: 'The growth in total employment, measured in standard labour units, accelerated from 0.2% in 1989 to 1% [in 1990] (-0.1% in the manufacturing sector), contrasting with the deceleration in GDP growth. The divergence was due to the lagged response of employment to the sustained economic expansion of the eighties'. According to the Bank, overtime declined from 5.6% of total worked-hours in 1989 to 5.1% in 1990, and the recourse to the 'wage supplementation fund' increased of 53.5% in 1990. Those two factors caused the number of worked-hours to fall of 2.4% (Banca d'Italia 1991, 1992). In 1991 the recourse to the fund increased of 87.8%. Only in 1992 'the continuing recession probably induced many firms not to postpone the

necessary adjustments in their work-force any longer. As a result, [in 1992] employment declined more sharply than in 1991 (...), more than wiping out the modest increase recorded over the three years from 1987 to 1989'. In 1991 overtime fell at 4.9% of total hours worked and many workers previously receiving benefits from the wage supplementation fund were finally dismissed by their employers (Banca d'Italia 1992).

Appendix 5

Results of factor and cluster analyses

The variables used in principal component and cluster analyses have been listed in Ch.6[1].

Principal components analysis reduced the number of variables to 7 (also called 'latent factors' or 'principal components'). These principal components explain 75% of the total variance of the original data matrix. An economic interpretation of the 7 components can be provided by looking at their correlation with the original variables (that they are supposed to synthesise).

factor 1: is positively associated to continuous R&D (var.1) and negatively to the absence of R&D (var.1B).

factor 2: is linked to those variables that represent the financial effort of firms in innovative activities (var.2, 3 and 4).

factor 3: is positively linked to the share of sales consisting of significant product innovations (var.15), and negatively to the share innovated from the point of view of processes (var. 13).

factor 4: is related to the relevance of occasional R&D activities (var.1A).

factor 5: is associate to the share of innovation costs devoted to design (var.7) and to incremental product innovations (var.14).

factor 6: is linked to the importance of trial production(var.8) and marketing (var.9).

factor 7: is associated with the importance of the acquisition of licenses.

On the basis of these factors, cluster analysis has carried out using a 'non-hierarchical algorithm' (the software used was SAS-Fast-Clus). The next problem was to find the optimum number of groups. A 'local optimum' number has been selected on the basis of two tests (PSEUDO F and Cubic Clustering Criterion). The selection of a 'global optimum' number would have resulted in a too large number of groups.

[1] It can be noted that variables [1], [1A] and [1B] are 'qualitative' (not-metric), while factor analysis is best applied to metric variables. However the statistical package we used (SAS) permits to transform non-metric in metric variables (PRINQUAL, qualitative principal component analysis).