THE ECONOMIC CONSEQUENCES OF INNOVATIONS IN ITALIAN MANUFACTURING FIRMS: THEORY AND RESULTS FROM THE COMMUNITY INNOVATION SURVEY

ESRC Centre for Business Research, University of Cambridge
Working Paper No. 40

Sergio Cesaratto
Dipartimento di Economia Pubblica
Universita di Roma 'La Sapienza'
Via Castro Laurenziano
00161 Roma
Italy

Fax: + 39 6 446 2040

Antonella Stirati
Dipartimento di Economia Politica
Universita di Siena
Piazza San Francesco 7
53100 Siena
Italy

Fax: + 39 577 298 661

September 1996

This Working Paper relates to the CBR Research Programme on Small and Medium-Sized Enterprises.

Abstract

The first part of the paper discusses alternative approaches to the macroeconomic impact of innovations introduced at the firm level. On this basis, the second part investigates the economic performance of about six thousand Italian innovating firms participating in the European Community's Harmonised Innovation Survey. The results underline the promising performance of the small firms sector, and the importance of innovations from the viewpoint of exports.

Acknowledgements

We wish to thank our colleagues Sandro Mangano (Istat, Rome) and Franklin Serrano (Federal University of Rio De Janeiro) who worked with us in a study carried out for the European Innovation Monitoring System (European Commission, DG 13) on the employment effects of innovations (see Cesaratto et al., 1996). We are also grateful to Professor Luigi Frey, former director of the Dipartimento di Economia Pubblica of Università 'La Sapienza', Professor Paolo Garonna, general director of Istat, Dr Aldo Del Santo responsible within Istat for the Italian Community Innovation Survey, for their support. Research assistantship by Dr Marco Alfò is gratefully acknowledged. Presentations in May and June 1996 at the Universities of Cambridge (ESRC Centre for Business Research), Leicester (De Montfort University), and Pisa ('gruppo nazionale 40% - Politiche per l'occupazione') have been very useful. We thank the referee for comments. Antonella Stirati wrote paragraphs 2.1, 2.3.1, 5 and appendix 1; Sergio Cesaratto wrote the others.

THE ECONOMIC CONSEQUENCES OF INNOVATIONS IN ITALIAN MANUFACTURING FIRMS: THEORY AND RESULTS FROM THE COMMUNITY INNOVATION SURVEY

1. Introduction

This paper assesses the economic consequences of the innovations introduced by a large sample of Italian manufacturing firms over the period 1990-92 in both a theoretical and an applied perspective, on the basis of the results of the Community Harmonized Innovation Survey (CIS).

The purpose of the CIS has been to develop a new set of indicators of innovation inputs and outputs beyond the traditional R&D and patent statistics (Cesaratto et al. 1991; Archibugi et al., 1994). In particular, the European Union sponsored a survey carried out in 13 countries with a common questionnaire asking information on innovative activities carried out over the period 1990-92 in the manufacturing sector. National response rates have differed considerably (Archibugi et al., 1994, p.87). From the point of view of business participation, the Italian survey has been one of the most successful, with over 22,000 firms taking part in it. A process of evaluation of the CIS is under way. The present paper is a contribution to this process through the application of the results to a specific issue.

The impact of innovation on employment and economic performance may be studied at the firm, sectoral and aggregate level. At the firm level the focus is on the growth of the firm. More specifically, the concern is how different forms and levels of commitment to innovation affect performance. At the sectoral level the focus is on structural change, that is on the expansion/ contraction of specific industries and labour skills. The investigation of performance and structural change from the point of view of firm size may also be situated in one of these first two stages. At the aggregate level the focus is on the impact of innovation activities on the aggregate performance of the economy. In particular, it is at the aggregate level that the issue of technological unemployment should be addressed.

It is generally recognized that any unqualified jump from the micro and sectoral levels to the macro level is not justified[1]. This is because (i) although

innovations affect the *composition* of social output and employment within and outside the manufacturing sector, their *net* effect on the *levels* of output and occupation is not clearly discernible (e.g. innovators may displace non-innovators with nil net effects); in addition (ii) innovations in specific firms and sectors have impacts on other companies and industries within and outside the manufacturing sector. This is so even though, it is often said, without much justification, that it is from high-technology firms and sectors that we expect economic growth and new jobs[2]. On top of this, whatever the interest for the impact of innovation on firms' performance (which we intend to explore in future research), the remarkable size of the Italian survey suggested an attempt should be made in the direction of the appraisal of the macro-economic consequences of innovations. Accordingly, the first section of this paper is devoted to a discussion of alternative approaches to the impact of innovation on employment and economic performance, with particular reference to the relationship between the micro and the macro-levels.

On the basis of this discussion, in the following paragraphs we will illustrate some initial results from the Italian CIS. First we will compare the *aggregate* performance of about 6,000 innovating firms with two control groups. Second, by using simple regression analysis, we will explore the effect of innovation on performance at the firm level. We will finally look at the different types of small innovating firms, comparing their respective performances. The conclusions provide a synthesis of the results and allow policy implications to be drawn.

2. Alternative Approaches to the Impact of Innovation on Employment and Economic Performance

Three alternative approaches are discussed here: the neoclassical or mainstream, the Schumpeterian, and what may be defined as 'a long-period effective demand' approach (for a full discussion, see Cesaratto et al. 1995, 1996).

2.1. The neoclassical approach

Neoclassical theory maintains that the economy tends towards the full employment of the social resources. On the other hand, the growth rate of

these resources determines economic growth[3]. Technical change is the source of per capita productivity growth. Accordingly, the only long-period effects of technical change at the micro-level on the macro-level concern productivity growth[4].

Neoclassical theory also envisages the macroeconomic effects of innovation on the labour market which, however, are only of a frictional nature. The existence of demand functions for 'productive factors' (including labour) inversely related to their prices, characteristic of this theory, assures a tendency towards full-employment equilibrium as long as prices (including wages) are flexible. So, even if labour is initially displaced by innovations, lower wages would induce the use of more labour intensive techniques and/or a heavier consumption of labour intensive commodities, leading to the recovery of the lost jobs (in economic jargon, these 'substitution mechanisms' lead to a 'compensation effect' on the supply or production side). In this context, technological unemployment is admitted only as a short-run phenomenon due to structural imbalances in the labour market. Innovation and structural change may - other things being equal - increase the 'natural' or equilibrium unemployment rate. The adjustment process may require time, and may be hindered by inadequate retraining opportunities or by other obstacles to labour mobility and wage flexibility[5].

As a result, whatever the impact of innovation on employment at the micro-level, for neoclassical theory employment is a macro-economic issue, and the level of unemployment depends on the ability of the economy as a whole to adjust to structural change. The main macro-economic implications of the micro-economic performance concern the sources and the factors affecting productivity growth (e.g. the role of alternative market structures). Accordingly, innovation at the firm level is seen as the source of new, high productivity jobs that replace those lost in declining activities. International trade theory, including the emphasis on increasing returns of so-called 'New trade theory', is not an exception to this view, since the interest is not in the macro-economic effects of international competitiveness (say the effects of innovation on exports and the balance of payments), but remain mainly micro-economic in nature with price flexibility taking care of the aggregate level.

2.2. The Schumpeterian approach

According to this approach economic growth is a micro-grounded process, in which technological competition between firms boosts autonomous gross investment (investment that is not determined by demand growth or by physical obsolescence) and social consumption. It interesting to note that in this view economic growth has its roots in the supply side (e.g. in the competitive process and in 'entrepreneurship'), but its effects take place on the demand side, i.e. in investment, consumption and, in an open economy, on exports. In spite of Schumpeter's (1936) own rejection of Keynes' *General Theory,* some modern Schumpeterian economists see in this a convergence with the theory of Effective demand (e.g. Freeman et al., 1982).

In the Schumpeterian view, technological unemployment is admitted as a short-period phenomenon, since innovation fosters long-term growth[6]. The difference with the neoclassical view is that the 'compensation effect' offsetting technological unemployment is on the Effective demand side (and does not rely on factor substitutability to obtain the adjustment of demand to the supply of resources in 'efficiency units').

In the Schumpeterian perspective the analysis of the micro-data is important - in spite of the above-mentioned limitations - because the more diffused and successful innovation and entrepreneurship are, the more likely the positive effects on Aggregate demand.

2.3. The LED approach

A different approach to economic growth may be found in the tradition of Keynes, Kaldor and Kalecki. We call it the 'long-period Effective demand' approach (LED) because it is based on the idea that Effective demand determines output levels in the long-run as well as in the short run[7]. According to LED, innovation positively affects productivity but with possible lasting negative effects on output and employment. The existence of automatic 'compensation effects' on the supply side is rejected. A cautious approach is taken with regard to the 'compensation effects' on the demand side.

2.3.1. On the supply side, the old Ricardian thesis that technical change may cause persistent unemployment appears correct in the light of the criticism

by Sraffa and others of the neoclassical 'substitution mechanisms' and the recovery of the classical economists' point of view[8]. Since is not *necessarily* associated with the acceptance of Say's law, the Ricardian approach is open to the investigation of compensation effects and policy prescriptions on the demand side. Instead, the existence of compensation effects on the demand side is ruled out in principle by neoclassical theory (demand is, on average, adjusted to supply). However, the thesis that technical change positively affects demand growth and employment calls for numerous qualifications.

2.3.2. Innovations may affect Effective demand through the following channels:

(a) innovations may positively affect the marginal propensity to consume and autonomous consumption (consumption financed by credit or existing wealth); this is true not only for new products, but also for process innovations that transform luxury goods into mass products.

> Objections: the impact of innovation also depends on income distribution (e.g. Sengenberger and Wilkinson, 1995, pp.127-28) and on the availability and cost of credit to consumers[9].

(b) innovations may positively affect 'autonomous (gross) investment', that is that component of total gross investment that is not induced by the (expected) growth rate of Effective demand. Technical change affects autonomous investment by influencing: (i) the early scrapping of plants by making capacity economically obsolete (both in a single industry, and in the economy by the fast expansion of new industries and the accelerated decline of old ones); (ii) by stimulating capacity creation in order to displace competitors[10].

> Objections: The effects of technical change on the level of gross investment are uncertain. For instance, if structural change favours less capital-intensive sectors this would decrease the overall capital/output ratio and, *ceteris paribus*, the level of gross investment is correspondingly reduced. In addition, fast technical change, by creating the expectation of a rapid economic obsolescence of equipment, may induce capital-saving innovations (Caminati, 1986) or the postponement of investment

(Rosenberg, 1986). On top of this, in order to sustain a given level (let alone a positive growth rate) of (gross) autonomous investment, technological competition must be persistent over time and over sectors, which cannot be taken for granted, either theoretically or empirically. Indeed, Schumpeterian economists fail to explain how the *cyclical* effects of innovation can generate an upward *trend* in the economy. Finally, causality could be reversed: demand side considerations may be important in the explanation of the rate of innovative activity (Schmookler, 1966; Geroski and Walters, 1995; Cesaratto, 1996).

(c) Finally, innovations may positively affect exports and diminish the marginal propensity to import; both effects stimulate aggregate demand and relax the foreign constraint on domestic expansionary policies.

To sum up, according to LED, the analysis of micro-economic data is of obvious relevance to the analysis of structural change (that is the change in the composition of social output and employment) and to the study of the impact of innovation at the firm level. However, structural change should not be confused with aggregate economic growth[11]. As a result, not much can be concluded from the performance of innovating firms regarding the macroeconomic effects of innovations.

One exception is the case of the effects of innovation on exports. For any single country, export growth can facilitate output and employment growth by supporting effective demand and by relaxing the balance of payments constraint. If a group of innovating firms is doing well in terms of export performance compared to the non-innovating firms, then one can safely conclude that innovation plays a positive role in the overall output and employment performance of a country[12]. From this perspective, also, the information on structural change is of value in appraising the long-period international competitive position of an open economy.

3. The Data Base

In the next section we compare the economic and employment performance of three panels of manufacturing firms over the period 1989-1992: (i) almost 6,000 innovating firms (IF), (ii) over 9,000 non-innovating units (NIF), both

surveyed by the 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 plus 11,000 other firms (OF) that did not participate in the CIS[13]. The SERF has been useful both because it extended and completed the information available from the CIS, and because it served as a proxy for the overall performance of Italian manufacturing firms. Various methodological problems have been faced.

To begin with, the CIS was not designed to assess the occupational impact of innovation. We compensated for this shortcoming by using information on labour inputs and other economic variables from the SERF. Unfortunately, the additional information was only partially satisfactory. In particular, the employment figures are gross of temporary lay-offs[14] and information on hours worked is available only for blue-collar workers.

Secondly, the CIS relates to a limited number of years, 1990-92. This is too short a period for measuring the long-run impact of innovation on output and employment which is, over short periods of time, strongly affected by the trade cycle.[15] However, it might be appropriate to assume that the cycle and the economic policies affect all firms (IF and NIF) to the same degree, so that the effect of innovations on employment can still be assessed. It should also be noted that we investigated panels of firms continuously operating over the period 1989-92. Thus, we have neglected firms' births and deaths, a major source of job creation and destruction[16].

Thirdly, the definition of IF is a loose one. This is so not only due to the usual difficulties surrounding the concept of innovation[17], but also because, in principle, some NIF and OF may have introduced innovations immediately before 1990-92, a period in which they were actually innovating firms. Conversely, innovating firms may have introduced innovations only at the end of this period. Evidence from the data indicates that IF display a higher *level* of productivity (measured by per-capita or per-worked hour productivity) than the other two groups. This suggests that the Italian CIS has effectively discriminated between high-productivity IF and low productivity NIF.

The composition of the three panels of firms is shown in table 1. As expected, the set of IF includes larger shares of R&D-oriented sectors and of medium

and large firms than the other groups. Nonetheless, over 5,000 firms with less than 200 employees are present among IF (accounting for about 36% of total employment in IF). Interestingly, the main differences emerge between IF and NIF, whereas the distribution of OF (firms not surveyed by CIS) is closer to that of firms included in SERF. This created some expectations that OF behave like the total population (SERF). This expectation was partially fulfilled during the analysis. This is a reassuring result, because it shows that the proportion between IF and NIF that emerges from the CIS sample is to an extent representative of the larger sample from SERF. In addition, the latter can be considered as representative of the average behaviour of the total population of IF and NIF.

The next section will present a descriptive analysis of the aggregate results of the three panels. The tables present weighted averages of the values at the firm level[18]. On the one hand, this procedure magnifies the role of larger firms. On the other, the substantial size of the samples suggests a comparison of the aggregate results. The econometric analysis carried out in section 4 looks at results at the firm level.

4. The Impact of Innovation on Economic Performance: Aggregate Results

4.1. Output, labour inputs and productivity

The rates of growth of value-added in real terms (table 2) show that over the period 1990-92, the performance of IF was similar to NIF and worse than SERF firms (the rates were 1.9% in IF and NIF, and 2.6% in SERF). The exceptions 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 1990-92 the average annual growth rate of (gross) employment of IF was 0.37% against -0.45% and -0.11% of NIF and SERF, respectively (table 3). By contrast, the average annual growth rate of total hours worked of IF was -1.64% against -1.32% and -1.56% in NIF and SERF, respectively.

The results of IF in terms of (gross) employment and hours worked are clearly divergent, particularly in 1990 and 1991 in IF and SERF. This divergence is discussed in appendix 1. The main reason for the divergence is clearly that the employment figure is gross of lay-offs, so that it underestimates the employment decline of the early 1990s (especially in IF where recourse to 'Cassa integrazione guadagni' is likely to be more common). From this we conclude that hours worked appear a better indicator of the net variations in the use of 'labour-inputs'. Of course, this indicator is only a proxy for the variation of the number of total employees, as it concerns only blue-collar workers and includes variations in overtime. A second reason for the divergence is a large, one-shot recruitment in the car industry that took place in 1991 in a newly-built plant in the South of the country. The exclusion of the car industry leads to a reduction of the gap between the two indicators, and to consistent signs (on average IF decreased employment and hours worked by -0.25% and -1.62% over 1990-92, against -0.38% and -1.49% for SERF, see table 3bis and 17).

Table 3 shows 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[19]. Once the car industry is excluded (table3 bis), the employment results for the R&D-oriented sectors in IF and SERF become negative. It can be concluded that whereas the non R&D-oriented sectors do better in terms of hours worked, they do not perform worse in terms of employment.

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 -0.52% and -1.10%, respectively; and -0.28% 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 (0.60% and -1.56%, respectively)[20]. These data show that while process innovations do not favour a greater use of labour-inputs, it is not clear whether more favourable results can be expected from product innovations.

Looking at this data, the overall performance of IF from the point of view both of output and of the use of labour inputs does not appear better than that of NIF and SERF[21]. Given the effects of innovations on productivity, we did not expect IF to show a better employment performance than the other groups. Yet, the fact that the output performance was also poor introduces some concern regarding the long-period competitiveness of the Italian manufacturing sector, at least in view of the prevailing opinion that the output composition of industrialised countries is likely to change in favour of new industries (e.g. Pianta, et al., 1996). However, closer inspection of the results suggests some qualifications.

A first qualification concerns small IF. In this case both the labour-input indicators provide consistent and encouraging results: the growth rates of employment and hours worked in small IF were 2.44% and 0.63%, respectively (see figure 1 and table 3). Only in 1992 did small IF start to reduce hours worked while still showing a positive (gross) employment growth. Small firms did better than medium and large firms also among NIF and SERF (but only small IF showed a positive value for both indicators).

Conversely, large IF display a poor employment record, particularly once the car industry has been excluded.

Over this period, the average annual productivity growth rates[22] of IF, calculated as the variations of real value added/total hours worked (table 4), were slightly higher than NIF but lower than SERF (3.5%, 3.2% and 4.1% in the three groups, respectively)[23]. In terms of per-capita productivity IF show the lowest 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. As a result, 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.

4.2 Indicators of structural change

Gross job turn-over

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 resulting 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 underestimate 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 job turn-over is usually higher in small firms)[24].

The lack of labour market flexibility is seen by mainstream economists as an obstacle to structural change (see above para. 2.1). While the results concerning gross job turn-over do not permit the rejection of the hypothesis that labour market rigidities discouraged more structural change in the Italian manufacturing sector over the years 1990-92, they do show that, in the given institutional context of the Italian labour market, IF have not seen greater structural change in terms of job turn-over compared to the other groups (in 1992 the figures for the three panels are 11,7%, 12.1% and 12.9%). Therefore, 'technological shocks' cannot be advocated without reservations as a source of labour market maladjustment requiring more flexibility. In addition, the figures are roughly in line with those obtained for economies where the labour market is considered more 'flexible'[25].

Employment composition

The share of women is lower in IF (table 6), both in terms of total labour-force (0.21%) and of white-collar workers (0.25%) compared to the other two panels (0.34 and 0.38 in NIF, and 0.26 and 0.29 in SERF, respectively). The share is higher in non-R&D-oriented and small units. There is no evidence of changes over the period in question.

The average share of white collar workers in IF is 0.33% against 0.20 in NIF and 0.25 in SERF (table 7). It is higher in R&D-oriented sectors and increases

with size. There is an upward trend, especially in IF, from 0.32% in 1989 to 0.34% in 1992. 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.

Finally, the brevity of the period under consideration does not allow any major change to be observed in the distribution of output and labour by sector and firm size. Yet it may be noted that, in terms of hours worked and of value added, the share of non-R&D-oriented sectors increased in all groups from 1989 to 1992. 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 by 1% in terms of employment, 2.2% in terms of hours worked, and 3.3% in terms of value added.

4.3 Investment and exports

Investment

The share of value added devoted to investment in machinery is higher in IF compared to NIF and SERF (respectively, 15%, 10% and 13% over 1989-92, see tab.8). In all groups, the non R&D-oriented sectors show a higher share than the R&D-oriented sectors (e.g. 0.16 and 0.14, respectively, in IF). This may depend on the relative importance of incorporated innovations in the non-R&D-oriented sectors. In all panels large firms show a greater propensity to invest than small firms (e.g. 0.16 and 0.13, respectively, in large and small IF). This is consistent with the results of a classification of the innovative behaviour of small IF presented below according to which only about one third of them introduce innovations merely by the acquisition of new machinery.

Over the period 1990-92, IF exhibit a positive average annual rate of growth of investment in machinery calculated in real terms (0.12%). The opposite happens in the other two groups (-7.08 and -1.85, respectively). The comparison of the behaviour of firms over the cycle (see figure 2) is particularly important in view of the Schumpeterian thesis of a 'compensation effect' offsetting technological unemployment on the demand side through

'autonomous investment'. IF were still increasing investment in 1990 during the final phase of the expansion, when many classes of NIF were already decreasing it[26]. 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.

To sum up, IF exhibit a higher propensity to invest, and 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 technical change has a positive effect on gross investment independently of demand conditions. 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 were also seriously affected by the fall in effective demand caused by the deflationary policies adopted in Italy and elsewhere. In addition, the different propensity to invest of different classes of firms (which may reflect structural as well as cyclical factors) suggests that structural change may affect the overall capital/output ratio in uncertain directions (see section 2.3 above). In our case, the relative growth of the non-R&D-oriented sectors tends to raise it, whereas the growth of small firms tends to lower it.

Exports

The export performance of IF suggests another qualification to the dismal results shown by IF that emerged in section 4.1. We shall look at the export performance of our panels from various viewpoints. First, we compare the propensity to export and export growth. Next, we will focus on the composition of exports within each group. Finally, we look at the importance of IF within total exports from SERF.

The *propensity to export* (share of exports in total sales) 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; see table 9). In all groups this share increased over the period (from 25% to 27% in IF).

The propensity to export of R&D-oriented sectors is larger than non-R&D-oriented sectors both in the IF and SERF. IF belonging to non R&D-oriented sectors show a lower propensity to export than NIF in the same sectors. The share of exports in total sales increases with firm size in the IF and SERF groups. Small IF exhibit a greater propensity to export than the total average for SERF (24% and 23%, respectively).

Export growth in real terms (table 9) was higher in IF (the average annual rate was 4.8% in IF, against 3.2% and 3.9% in NIF and SERF, respectively)[27]. Among IF, the highest growth rates were shown by non R&D-oriented firms (8.4%) and small firms (9.3%). The small firms exhibited the best outcome in all panels. The promising results of IF, together with the dismal outcomes in terms of value added growth shown above (section 4.1), suggest that IF behave asymmetrically in the domestic and foreign markets. We will discuss this point later.

Let us first look at how exports from each of the three panels are distributed according to different classes of firms (table 10).

Among IF, the R&D-oriented sectors and large firms have the highest 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, looking at SERF (that is a proxy for the total exports of Italian firms with over 20 employees), the weight of exports from large firms precisely matches that from small firms, both accounting for slightly over 40% of total exports. Further evidence suggests that between 1990 and 1992 the share of small firms increased in all three groups, while that of the R&D-oriented sectors remained roughly constant.

Tables 11 and 12 provide additional information on the role of these different categories of firms - IF, NIF and OF - in the structure of Italian exports (as proxied by SERF).

Table 11 shows *the share of IF, NIF and OF in total exports for each class* in 1992. Some 53.7% of total exports came from IF (the share increased from 52% in 1989). By comparison, the share was larger than the share of IF in total value added (48.4%). The share of exports of IF was highest in the R&D-oriented sectors and among large firms (67.4% and 78.7%, respectively, of total exports in each of these classes). It was lower among the non-R&D-oriented sectors and small firms (34% and 30%). Conversely, the contribution of NIF and OF to total exports (14.3% and 32.7%) was lower than their shares of total value added (15.9% and 35.6%).

Table 12 breaks down *the share of total exports (from all classes of SERF firms) covered by each class of IF, NIF and OF.* For instance, the 53.7% of total exports that come from IF is composed of 14.3% from non-R&D-oriented sectors and 39.4% 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.

These tables suggest some conclusions. Looking at the composition of exports, the R&D-oriented sectors and the largest companies have the greatest share of exports from IF. However, exports from IF in the non-R&D-oriented sectors and from small IF show higher growth. This suggests a restructuring of Italian exports toward the non high-technology section of the industrial spectrum, a process perhaps accompanied by an increasingly innovative content of traditional production. Secondly, although small IF have increased their share, they still play a secondary role as regards total exports from SERF firms. Only 13% of these exports originates from small IF, compared to a share from all small firms of above 40%. Looking at IF as a whole, they account for over half of exports from SERF firms (against less than half the output). Considering the figure from the national accounts, in terms of total visible exports, IF chalk up a share of 36.6%, higher than the share of total value added in the manufacturing sector (29.2%). In this regard, any conclusion is of a speculative nature. A number of IF may be present outside the CIS sample (say among OF or as firms with less than 20 employees). Having said this, the figures suggest that the majority of Italian exports do not come from IF. Of course, this does not imply that innovation has a negative effect on Italian exports (and indirectly on output and employment), quite the opposite, as shown by the higher propensity to export of IF.

Finally, over the period 1990-92 IF show an asymmetric behaviour, with an above average growth of exports and a below average domestic performance. This can clearly be seen from a breakdown of the total growth rate of sales (here expressed in nominal terms) into domestic and foreign components. Table 13 shows the ratio between the growth rate of exports (weighted by the share of exports on sales) and the growth rate of total sales. IF exhibit a larger export component (37% against 27% of NIF and 29% of SERF), which increases over the period faster than in the other groups (from 25% in 1990 to 60% in 1992). The behaviour of large IF explains this result. In 1992, in particular, domestic sales of large IF fell by 1.38% against a positive growth of 0.86% in foreign sales. Large IF have probably been hit particularly hard by the domestic deflationary policies[28].

5. Explorative Regression Analysis

A simple regression exercise using Generalised least squares was performed on IF and NIF to test the effects of being innovative on the growth rate of (gross) employment (Y1), growth rate of hours worked (Y2), the growth rate of exports (Y3) and of value-added (Y4) at the enterprise level . The independent variables were:

Z1 = a dummy variable indicating the introduction (or non introduction) of innovations over the period 1990-92;

Z2 = firm size measured by the number of employees in 1989;

Z3 = the industry firms belong to.

Table 14 shows the results of the exercise. The values of the multiple correlation coefficient R2 are always low. This is hardly surprising in an exercise carried out on almost 6,000 observations using only a few independent variables. Behaviour at the level of the individual firm can indeed depend on many factors, some of which are of a very specific nature, that are not easy to capture in statistical surveys or in any simple model. Only in the case of the first two equations is the global model 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 (Y1) and hours worked (Y2). Firm 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 positively influences the growth rates of exports and value added, but the coefficients are not significant. The same is true for the negative effects of firm 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. 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 (which are by far the majority in the IF sample), which we know from tables 2 and 3 have performed better from this point of view. The fact that size does not apparently have a significant effect on variations in 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 perform relatively as well 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 was the absence of significant effects of innovativeness 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.

6. Innovation Patterns and Economic Performance in the Small Firm Sector

The CIS provides a variety of data on the input and output of innovative 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 (Archibugi, Cesaratto and Sirilli, 1991; Cesaratto and Mangano 1993; Cesaratto et al. 1996). Given the importance of small firms in job creation, as emerged from section 4 and from the literature, we have focused on innovative behaviour in small firms (defined as those with less than 200 employees). A summary of the statistical approach and some further results are presented in appendix 2.

Cluster analysis was applied to 5,329 small firms. 7 main types were obtained (figure 3). On the one hand each type contains a variety of sectors, although some are more significantly represented than others; on the other, each sector is spread over a number of types, although more concentrated in some of them. This shows the difference of this classification, as an approach to the variety of innovative behaviour, over the seminal sectoral approach originally advanced by Keith Pavitt (1982).

The wide variety of types of innovating behaviour which are found among small firms is remarkable. The share of firms carrying out institutional R&D (firms in types 1, 2 and 3 are 35.7% of the sample) is close to that of those which innovated in the traditional way of introducing embodied innovations (type 7 is 38.1%). However, small 'Schumpeterian' high-technology firms are few in number (types 2 and 3 account for only 0.4%). The other major groups are those relying on occasional R&D (type 4, 16.7%) and industrial design (type 5, 7.5%).

Tables 16 and 17 compare the performance of the different types. The most significant result is the promising performance of the R&D-based firms, both from the economic and the employment viewpoints[29]. In addition, these firms account for almost 56% of total exports from the sample of small IF, ten percentage points more than the share of value added (46%). By contrast, more 'traditional' small firms that base their innovations on occasional R&D and embodied innovations generally display below average results. Design-based firms tend to show average performance.

7. Conclusions

Summary of the findings

The implication of the CIS results with regard to the effects of innovation on employment should be considered with some *caveats*. The limitations of the available labour-input indicators, the lack of information on firm births and deaths, and the short period covered by the CIS, suggest that any conclusions concerning the *direct* impact of innovation on the performance of IF should be drawn with caution. The implicit assumption that the business cycle affects IF, NIF and SERF firms to the same degree should also be taken into account. Moreover, it should be recalled that IF have been defined on the basis of innovations introduced some time in the period 1990-92. This is a very loose definition of IF, since NIF and SERF firms may have introduced innovations immediately before this period. Conversely, IF may have introduced innovations at the end of the period (say in 1992), that is, too late to affect their performance. In addition, the direction of the causal relationship between innovation and performance cannot be defined *a priori*. Innovation may generate good performance, but also be the result thereof or, in other cases, of a reaction to poor performance[30]. Lastly, the theoretical discussion of section 2 showed the difficulties of drawing general implications from micro-economic behaviour.

The main findings are as follows:

The IF group as a whole does not perform better than the control groups in terms of output and labour-input growth. However, two important asymmetries emerge, namely between small and large firms, and between domestic and export performance:

(a) To begin with, small IF exhibit better employment and output performance than any other class of firms (to help the reader, figure 4 summarises some results referring to small IF and all IF, respectively). This is in line with similar results in other countries (OECD, 1994, 1995)[31]. The classification of innovative types of small firms suggests that the best performers in terms of employment and other economic variables are small IF that innovated on the basis of continuous R&D activities. Regression analysis confirms that, at

the firm level, both innovativeness and small size (measured by the number of employees) have a positive effect on employment.

(b) Secondly, IF show a better export performance than the control groups. Correspondingly, they show worse results in the domestic market. This asymmetry, especially strong in the case of large companies, needs further exploration. The results of regression analysis suggest that, although the aggregate effect of innovation on export growth is positive, it is not statistically significant at the firm level (although the sign of the regression coefficient is still positive).

IF exhibit a higher propensity to export. The structure of Italian manufacturing exports shows a polarisation between large, R&D-oriented companies and small, traditional firms, with small innovating firms playing a secondary role.

IF have a higher propensity to invest and to reduce their investment in plant and machinery later and to a lesser 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 viewed with great caution. Indeed, the results suggest that, though to a lesser degree over the years considered compared to the other groups, investment decisions by IF have also been seriously affected by the fall in effective demand caused by the deflationary policies adopted in Italy and elsewhere. However, they may perhaps play a stabilizing role over the short period.

Innovativeness is linked to higher shares of qualified workers - measured from the share of white collar workers. The latter share 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 increased more in IF lends some support to the first hypothesis. This is consistent with the widespread view that, at present, technical change, accompanied by competition from low-wage newly industrialising countries, is leading to the expulsion of low-skilled workers.

Innovation does not favour female employment. The latter is higher in small non-innovating firms in 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 in the labour force did not change substantially over the period in question.

Policy implications

Previous research has indicated that in Italy the most innovative industries have had a worse economic and occupational performance in recent years (e.g. Pianta, 1995). This result is in contrast with that of other industrialized countries where innovative industries tend to grow faster than declining traditional sectors.

This paper confirms this result, although with some qualifications. First, in spite of the absence of a positive association between innovation, on the one hand, and output and employment, on the other, there is an association between being innovative and export performance. Of course, the definition of 'being innovative' adopted in this paper is a loose one, as it includes activities other than R&D. In future research more attention will be paid to the impact on performance of specific innovation inputs and outputs. However, the loose definition adopted here could be effective in covering the variety of innovative behaviour typical of the Italian manufacturing sector. Second, the promising export performance of IF suggests that, from this point of view, innovation has contributed to economic growth and job creation in the Italian economy[32]. In the case of large firms, an increasing export effort has compensated for the difficulties in the internal market. It is important to note that this promising behaviour preceded the devaluation of the Italian lira on September 1992[33]. Finally, the paper highlights the positive performance of the small firm sector.

In terms of innovation policy, our results re-propose the old dilemma of whether and for how long Italy can successfully pursue her peculiar model of being innovative in the traditional, small firm sectors, and what dangers are likely to arise in the long run from lagging behind in R&D-oriented industries and from the decline of large firms[34]. To some extent, this model should not be opposed, as far as it goes (and it has already gone very far). In

addition it could provide a valuable example for the 'Mezzogiorno' region, if better environmental conditions can be assured there in order, for instance, to attract interfirm co-operation and investment from small firms in the north. Nonetheless, there are no clear-cut policies for improving Italian competitiveness in R&D-oriented production. The promising performance of small firms that carry out continuous R&D suggests an effort should be made in this direction. From another study (Stirati and Cesaratto, 1995) we gained the impression that Italian firms are not deaf to the need to perform research, but do not like taking the risk of long-period investment in *in-house* R&D, and would rather prefer to see universities doing research for them. Although cooperation between universities, research institutions and industry is a good thing, every component of a research system has to play its own specific role. Firms should be encouraged to invest in *intra-mural* R&D, and so provide employment opportunities and R&D facilities for young researchers[35].

In a more general perspective, we believe that in an open economy innovation is a good thing, whatever its direct effects, negative or positive, on employment, since international competitiveness depends, *inter alia*, on the technological content of exports. The rule of one instrument for each objective of economic policy should apply to innovation policy. The pursuit of greater technical change should be linked to international competitiveness and to the relaxing of the balance of payment constraint, and not to job creation. The target of full employment should rely upon more traditional macro-economic policies (see Cesaratto et al., 1996, Ch.4).

Notes

1. For instance, a recent major conference was based on papers investigating the impact of innovation on employment at the firm level (OECD, 1995). In his conclusions, however, Professor Zvi Griliches warned that whatever the interest of this approach for the micro level, the implications for the macro-level were not clear.

2. For the sake of example, a recent LSE working paper triumphantly concludes from an analysis at the micro-level that 'The Luddites were wrong' (Blanchflower and Burgess, 1996, p.18).

3. For a more thorough discussion of neoclassical growth theory see Cesaratto, 1997.

4. This is clear from the neoclassical attempt to measure the contribution of technical progress to productivity growth.

5. A recent influential institutional document on employment reflects the mainstream interpretation of 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, 1994, p.vii)'.

6. Professor Chris Freeman recently reproposed this view in *STI-Review*: '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 a 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 Schumpeterian views are sometimes adopted, as their last resort, also by neoclassical economists. This is how the OECD editors of the *STI-Review* embodied Professor 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). This quotation shows that conventional economists are ready to accept any policy prescription, as long as it excludes government intervention.

7. Long-period Effective demand is the demand forthcoming at normal prices. The Smithian notion of 'Effectual demand' is the sectoral counterpart of Effective demand. For this approach, see Serrano 1995, 1996; Cesaratto et al., 1995.

8. David Ricardo initially maintained and later challenged the conclusion, that shows striking similarities to the neoclassical one, 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). Later, 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 a 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.

The interest and the force of the 'Ricardian case' have been renewed by the recovery of the Classical approach by Sraffa (1951). He 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. Failure to perceive this crucial difference has often led to misinterpretations of the 'Ricardian effect' as a 'transitory' or 'short run' phenomenon.

In addition, Sraffa (1960) suggested that not only were the neoclassical substitution mechanisms absent in the classical approach, but that their later introduction was flawed by *logical* inconsistencies. This inspired in the 1960s what has probably become the most famous controversy in economic analysis, concerning the neoclassical notion of 'capital'. Put simply, this controversy pointed to the peculiar nature of the 'capital', which is not an 'original' factor measurable in some conventional unit, as is the case for labour or land, but a produced commodity that is measurable only in 'value'. This has important consequences for the reliability of the neoclassical substitution mechanisms, given the dependence on distribution of capital thus measured.

9. It has been persuasively maintained, particularly by a group of Anglo-French economists known as 'Regulationists' (e.g. Boyer 1988), that the 'golden', full-employment years of post-war capitalism have shown a positive association between productivity growth, aggregate demand and employment. The institutional framework favourable to workers ('wage-led' regime) was the main factor behind this association. However, it is doubtful that without policy intervention the virtuous relation between technical change, aggregate demand and employment growth would ever have been established (see Cesaratto et al., 1995).

10. Schumpeterian economists have the vague idea that the greater aggregate demand induced by autonomous investment will justify capacity creation.

11. By contrast, neoclassical and Schumpeterian economists tend to see structural change as the main long-run cause of economic growth. Typically, they neglect the opposite causation.

12. Here the assumption is that domestic exporting firms are competing with foreign firms, not with other national companies.

13. The sets of IF and NIF analysed in this paper do not include all the firms participating in the CIS since the information from SERF was not available for all of them.

14. In Italy laid-off workers are supported by a 'wages supplementation fund' (Cassa integrazione guadagni).

15. 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 Italian GDP over the three years were 2.1%, 1.2% and 0.7%. The corresponding rates of growth of dependent employment (full-time equivalent) were 1.2%, 0.6% and -0.5% (source Istat, National accounts, 1988-94, mimeo).

16. A further drawback of the panels regards 'corporate transformations'. These consist of mergers and separations that may refer to a part or the whole of one or more companies (Istat, 1995, p.75; Contini and Monducci, 1995). 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 larger companies have been involved, mainly in the acquisition of smaller firms. Smaller companies indeed tend to sell off activities. Modern rather than traditional sectors are more likely to be involved in the transformations.

17. The following definitions concerning technological innovation were attached to the questionnaire: 'A *technology* can be interpreted broadly as the whole complex of knowledge, skills, routines, competence, equipment and engineering practice which are necessary to produce a product. A new product rests on a change in this underlying technology. More generaly, *innovation* occurs when a new or changed product is introduced to the market, or when a new or changed process is used in commercial production. The *innovation process* is the combination of activities - such as design, research, market investigation, tooling up

and so on - which are necessary to develop an innovative product or production process. We are concerned with products and processes which are *new to the enterprise*'. The questionnaire also requires respondents to exclude as innovations 'purely aesthetic' changes, or product differntiations that leave the product 'technically unchanged in construction or performance'.

18. For the sake of simplicity, at this stage we have not commented upon data at the industry level but have aggregated sectors into two groups according to the prevalence in each industry of firms carrying on continuous R&D activities. We have measured firm size in terms of number of employees, assigning each firm to the class it belonged to in 1989. This was a practical way of avoiding figures by firm size being affected by transitions from one class to another.

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

20. At this stage we could not separate the car industry (most of which is probably included among firms that innovated both in products and in processes).

21. In nominal terms, the value-added growth rate, 1990-92, in OF was 7.02%, higher than in IF (4.54%), NIF (5.05%) and SERF (5.47%). The growth rates of employment and hours worked in OF were -0.52% and -1.59%, respectively. Employment outcomes for OF were worse than those of SERF as a result of the poor performance of large OF. The outcomes in terms of hours worked were roughly the same as SERF.

22. 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, such as the one considered here, the main factor affecting productivity is the business cycle. The latter affects the degree of utilisation of existing productive capacity, that is, the output obtained from given amounts of physical and human resources. Technical change exerts its effects over longer periods of time.

23. In the case of productivity growth OF show a result that is better than IF and NIF (see footnote 22 above).

24. The values for 1991 are inflated by the above-cited large recruitment in car manufacturing.

25. According to the OECD (1994, table 1.8) the gross job turn-over in Italy over the period 1989-92, taking into account only 'expansions' and 'contractions' of firms (as we have done here), was 16.1% on average. The figure is higher than the one obtained here since it includes also firms with less than 20 employees. The corresponding figure for the United Kingdom was 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.

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

27. The average growth rate of exports in nominal terms over 1990-92 for OF, 8.82%, was close to that for SERF, 9.02%. The corresponding values for IF and NIF were, respectively, 12.06% and 6.36%.

28. Over the period 1990-92 the foreign component of the total growth rate of sales for OF was 18%. Domestic sales of large OF fell by -0.4%.

29. This result is in a sense the opposite of the one illustrated in Cesaratto et al. (1996). In that case the statistical analysis was conducted on about 6,300 IF with 20-199 employees *in 1992*. In this paper it concerns IF with 20-199 employees *in 1989*. As a consequence, the results are not strictly comparable. In the first case the performance of firms is underestimated since the sample includes all the medium size firms that downsized over the period and, symetrically, excludes all the firms that jumped into the higher classes. The procedure presented here is more appropriate.

30. 'Economic performance' is a vague concept. Given the 'macro-economic' implications we have attempted to draw here, the performance has been related to magnitudes such as output, employment and exports. Not least because of technical problems encountered in matching big data bases, the range of 'performance indicators' considered at this stage has not included magnitudes such as gross profit margins and wages.

31. In view of the Istat indication that small firms tend to sell activities to large companies (see footnote 16 above), had 'corporate transformations' been taken into account, the growth of the small firms sector would have been magnified.

32. This conclusion should be taken with a grain of salt because the propensity to import of IF has not been taken into account.

33. The delay in the availability of data from SERF for the period subsequent to the devaluation of the Italian lira in September 1992 has prevented us from assessing the impact of this major event on the export performance of the various types of firms. We plan to do this in the near future.

34. It should not be forgotten that recent research has shown that in Italy small firms are often financially and economically integrated, so that they are not really so small.

35. A further problem, which cannot be fully discussed here, is the role that the State has played in Italy in the high-tech sector. How does the decline of this role affect R&D capacity in the Italian manufacturing sector?

36. 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 hours worked in 1989 to 5.1% in 1990, and the recourse to the 'wage supplementation fund' increased by 53.5% in 1990. Those two factors caused the number of

hours worked to fall by 2.4% (Banca d'Italia 1991, 1992). In 1991 the drawing on the fund increased by 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 by 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).

37. Many firms did not fill out the part of the questionnaire concerning the distribution of innovation costs (which refers to internal sources of innovation). However, most of these firms put a figure for 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.

TABLES AND FIGURES

Tab. 1 - Distribution of number of firms, employment and value-added in IF, NIF, OF and SERF by sector and size. 1992
(column percentages)

	IF			NIF			OF			SERF		
	n. FIRMS	EMPLOYMENT	VALUE-ADDED	n. FIRMS	EMPLOYMENT	VALUE-ADDED	n. FIRMS	EMPLOYMENT	VALUE-ADDED	n. FIRMS	EMPLOYMENT	VALUE-ADDED
Non R&D-oriented sectors	54.1	35.8	35.6	74.5	73.9	71.9	68.0	61.4	58.5	67.2	52.3	49.6
R&D-oriented sectors	45.9	64.2	64.4	25.5	26.1	28.1	32.0	38.6	41.5	32.8	47.7	50.4
20-199	85.6	28.6	26.8	97.7	85.2	84.2	93.3	60.6	55.7	93.2	51.0	46.2
200-499	8.9	14.5	15.0	2.0	10.2	11.0	5.0	17.4	19.1	4.8	14.7	15.8
Over 500	5.5	56.9	58.2	0.3	4.7	4.8	1.7	22.1	25.2	2.1	34.4	37.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Abs.values (1)	*5962*	*1145626*	*88756155*	*9534*	*493036*	*29218915*	*11146*	*910471*	*65285397*	*26642*	*2549133*	*183260467*

Note: (1) Value added: thausands of Italian liras.

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.

IF: Innovating firms; NIF: Non-innovating firms; OF: Other firms; SERF: IF+NIF+OF.

Source: Istat: Community Innovation Survey (CIS), Indagine sul Prodotto Lordo (IPL).

Tab. 2 - Annual rates of growth of value-added in real terms in IF, NIF and SERF by sector and size. 1990-92. (percentages [2])

		1990	1991	1992	1990-92
INNOVATING FIRMS	Total	2.04	3.06	0.41	1.87
	Non R&D-oriented sectors	*2.25*	*3.23*	*1.72*	2.46
	R&D-oriented sectors	*1.92*	*2.97*	*-0.30*	1.55
	20-199	6.75	4.60	6.50	6.30
	200-499	7.85	1.86	3.05	4.40
	Over 500	-1.00	2.74	-2.72	-0.35
NON INNOVATING FIRMS	Total	2.82	2.38	0.39	1.89
	Non R&D-oriented sectors	*2.94*	*1.39*	*1.67*	2.56
	R&D-oriented sectors	*2.51*	*4.90*	*-2.77*	1.52
	20-199	3.76	2.41	1.06	2.46
	200-499	1.73	3.82	-3.49	0.64
	Over 500	-8.14	-1.02	-1.88	-3.59
SERF	Total	3.28	3.17	1.10	2.58
	Non R&D-oriented sectors	*3.56*	*3.08*	*1.90*	2.93
	R&D-oriented sectors	*3.01*	*3.26*	*0.32*	2.24
	20-199	5.22	4.03	3.84	4.55
	200-499	6.35	2.85	2.01	3.86
	Over 500	0.12	2.35	-2.33	0.03
	NATIONAL ACCOUNTS (1)	*1.90*	*-0.20*	*0.20*	*0.63*

Legenda: see table 1.

Notes:
(1) Manufacturing sector.
(2) In the tables, the values for 1990-92 or 1989-92 are simple averages.

Source: ISTAT: CIS, IPL.

Tab.3 - Annual rates of growth of employment and hours worked in IF, NIF and SERF by sector and size (1). 1990-92. (percentages)

		EMPLOYMENT				HOURS WORKED			
		1990	1991	1992	1990-92	1990	1991	1992	1990-92
INNOVATING FIRMS	Total	2.26	3.04	-4.04	0.37	-0.57	-0.06	-4.33	-1.64
	Non R&D-oriented sectors	1.75	0.80	-2.87	-0.12	1.35	-1.52	-2.18	-0.79
	R&D-oriented sectors	2.55	4.31	-4.68	0.66	-1.86	0.95	-5.77	-2.22
SIZE	20-199	4.86	1.54	0.78	2.44	2.83	0.00	-0.91	0.63
	200-499	2.10	-0.29	-1.42	0.12	-0.57	-2.97	-1.45	-1.64
	Over 500	1.10	4.59	-6.90	-0.52	-2.42	0.69	-7.02	-2.88
TYPE OF INNOVATION	*Both prod.&proc.*	*2.69*	*3.86*	*-4.56*	*0.60*	*-0.99*	*1.01*	*-4.68*	*-1.56*
	Only proc.	*0.16*	*-0.37*	*-1.37*	*-0.52*	*1.24*	*-2.86*	*-1.67*	*-1.10*
	Only prod.	*1.38*	*0.66*	*-2.83*	*-0.28*	*0.51*	*-4.65*	*-4.53*	*-2.84*
NON INNOVATING FIRMS	Total	1.74	-0.66	-2.38	-0.45	1.10	-1.43	-3.64	-1.32
	Non R&D-oriented sectors	1.53	-0.70	-2.37	-0.52	0.83	-1.18	-3.17	-1.17
	R&D-oriented sectors	2.33	-0.56	-2.40	-0.23	1.89	-2.16	-5.04	-1.77
SIZE	20-199	2.29	-0.44	-2.08	-0.09	1.66	-1.40	-3.93	-1.23
	200-499	-0.45	-1.79	-4.51	-2.21	-1.97	-1.83	-1.60	-1.77
	Over 500	-2.91	-2.03	-3.18	-2.63	-2.70	-1.04	-2.48	-2.03
SERF	Total	1.67	1.19	-3.12	-0.11	-0.41	-0.60	-3.70	-1.56
	Non R&D-oriented sectors	1.25	-0.18	-2.18	-0.38	0.32	-0.92	-2.46	-1.01
	R&D-oriented sectors	2.15	2.70	-4.14	0.19	-1.38	-0.17	-5.35	-2.27
SIZE	20-199	3.22	0.35	-0.50	1.03	1.86	-0.87	-2.11	-0.39
	200-499	0.97	-0.60	-2.72	-0.79	-0.83	-2.04	-2.63	-1.80
	Over 500	-0.18	3.13	-6.93	-1.40	-3.99	0.55	-6.94	-1.80
	NATIONAL ACCOUNTS (2)	*0.50*	*-2.20*	*-4.30*	*-2.00*	*na*	*na*	*na*	*na*

Legenda: see table 1.

Notes:
(1) Employment is gross of temporary 'lay-offs'; hours worked concern blue collar workers only.
(2) Annual growth rates of number of employees in the manufacturing sector in equivalent full time

Source: ISTAT: CIS, IPL.

Tab.3 bis - Annual rates of growth of employment and hours worked in IF and SERF with the exclusion of the Car industry (1). 1990-92.
(percentages)

		EMPLOYMENT				HOURS WORKED			
		1990	1991	1992	1990-92	1990	1991	1992	1990-92
INNOVATING FIRMS	Total	2.26	0.99	-3.90	-0.25	0.18	-1.40	-3.69	-1.62
	R&D-oriented sectors	2.63	1.13	-4.62	-0.34	-0.86	-1.28	-5.04	-2.35
	Over 500	0.81	1.07	-7.54	-1.93	-1.49	-1.89	-6.66	-3.26
SERF	Total	1.66	0.25	-2.99	-0.38	-0.07	-1.05	-3.37	-1.49
	R&D-oriented sectors	2.21	0.80	-4.02	-0.37	-0.70	-1.26	-4.84	-2.23
	Over 500	-0.62	0.51	-7.50	-2.54	-3.78	-0.86	-6.69	-3.66

Legenda: see table 1.

Notes:
(1) Employment is gross of temporary 'lay-offs'; hours worked concern blue collar workers only.

Source: ISTAT: CIS, IPL.

Tab. 4 - Annual rates of growth of productivity in IF, NIF and SERF by sector and size (1). 1990-92. (percentages)

		Per-capita productivity	Per-hour worked productivity
INNOVATING FIRMS	Total	1.50	3.51
	Non R&D-oriented sectors	2.58	3.25
	R&D-oriented sectors	0.89	3.76
	20-199	3.86	5.67
	200-499	4.28	6.04
	Over 500	0.17	2.53
NON INNOVATING FIRMS	Total	2.34	3.21
	Non R&D-oriented sectors	3.09	3.74
	R&D-oriented sectors	1.75	3.29
	20-199	2.56	3.70
	200-499	2.86	2.41
	Over 500	-0.96	-1.56
SERF	Total	2.69	4.14
	Non R&D-oriented sectors	3.31	3.94
	R&D-oriented sectors	2.05	4.51
	20-199	3.53	4.94
	200-499	4.65	5.66
	Over 500	1.42	1.83
	NATIONAL ACCOUNTS (2)	*2.63*	*na*

Legenda: see table 1.

Notes:
(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, IPL.

Tab.5 - Gross job turn-over (1) in IF, NIF and SERF by sector and size. 1990-92 (percentages)

		1990	1991	1992
INNOVATING FIRMS	Total	12.4	18.9	11.7
	Non R&D-based sectors	13.7	11.7	13.7
	R&D-based sectors	11.6	23.2	10.7
	20-199	13.6	9.4	13.4
	200-499	16.3	8.0	13.9
	Over 500	10.4	28.3	9.4
NON INNOVATING FIRMS	Total	12.8	7.9	12.1
	Non R&D-based sectors	12.8	7.7	11.7
	R&D-based sectors	12.5	8.3	13.2
	20-199	12.5	7.9	12.2
	200-499	14.3	6.6	13.4
	Over 500	10.1	10.6	7.4
SERF	Total	13.7	13.2	12.9
	Non R&D-based sectors	14.3	8.4	13.4
	R&D-based sectors	13.0	18.4	12.4
	20-199	14.0	7.3	13.8
	200-499	15.0	7.6	15.6
	Over 500	12.0	26.2	9.4

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

Source: Istat: CIS, IPL.

Tab. 6 - 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-based sectors	0.23	*0.32*	0.32	*0.42*	0.26	*0.34*
R&D-based 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, IPL.

Tab. 7 - 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-based sectors	0.25	0.26	0.25
	R&D-based 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-based *sectors*	0.17	0.18	0.18
	R&D-based 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-based sectors	0.22	0.23	0.22
	R&D-based 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, IPL.

Tab. 8 - 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, IPL.

Tab. 9 - Growth rates in real terms and 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	Growth rates			
		1989-92	1990	1991	1992	1990-92
INNOVATING FIRMS	Total	0.26	4.98	4.62	4.17	4.81
	Non R&D-based sectors	0.17	8.60	6.49	8.23	8.39
	R&D-based sectors	0.31	3.70	3.93	2.64	3.55
	20-199	0.24	12.97	4.25	9.38	9.27
	200-499	0.27	5.23	2.53	8.18	5.58
	Over 500	0.26	2.39	5.28	1.19	3.03
NON INNOVATING FIRMS	Total	0.21	3.81	1.60	3.94	3.21
	Non R&D-based sectors	0.20	4.20	1.80	5.50	3.98
	R&D-based sectors	0.27	2.98	1.19	0.64	1.63
	20-199	0.21	3.99	2.21	6.06	4.25
	200-499	0.24	0.56	12.06	-11.61	-0.13
	Over 500	0.23	7.16	-22.15	6.88	-3.61
SERF	Total	0.23	3.31	3.09	4.87	3.90
	Non R&D-based sectors	0.18	3.64	5.66	6.12	5.40
	R&D-based sectors	0.29	3.09	1.25	3.94	2.83
	20-199	0.22	5.94	4.70	8.19	6.67
	200-499	0.25	5.11	-0.51	3.81	2.85
	Over 500	0.25	0.10	2.90	1.84	1.64
	NATIONAL ACCOUNTS (1)		*4.40*	*1.60*	*4.20*	*3.40*

Legenda: see table 1.

Note: (1) Visible exports.

Source: ISTAT: CIS, IPL.

Tab. 10 - Distribution of exports in IF, NIF and SERF by sector and size. 1989-92
(column percentages)

	IF	NIF	SERF
Non R&D-oriented sectors	26.3	67.5	41.3
R&D-oriented sectors	73.7	32.5	58.7
20-199	23.6	82.7	42.4
200-499	15.1	11.3	16.2
Over 500	61.3	6.0	41.4
Total	100.0	100.0	100.0

Legenda: see table 1.

Source: ISTAT: CIS, IPL.

Tab. 11 - Distribution of exports in IF, NIF and SERF
by sector and size. 1992
(row percentages)

	IF	NIF	OF	SERF
Non R&D-oriented sectors	34.7	23.3	42.0	100.0
R&D-oriented sectors	67.4	7.9	24.7	100.0
20-199	30.3	27.4	42.3	100.0
200-499	50.1	9.4	40.5	100.0
Over 500	78.7	1.9	19.4	100.0
Total	53.7	14.3	32.0	100.0

Legenda: see table 1.

Source: ISTAT: CIS, IPL.

Tab. 12 - Distribution of exports from SERF between IF, NIF and OF by sector and size. 1992
(column percentages)

	ALL FIRMS	BY SECTOR		BY SIZE	
INNOVATING FIRM	53.7	*Non R&D-oriented sectors*	14.3	*20-199*	13.3
				200-499	8.2
		R&D-oriented sectors	39.4	*Over 500*	32.2
NON INNOVATING FIRM	14.3	*Non R&D-oriented sectors*	9.7	*20-199*	12.0
				200-499	1.5
		R&D-oriented sectors	4.6	*Over 500*	1.0
OTHER FIRMS	32.7	*Non R&D-oriented sectors*	32.7	*20-199*	32.7
		R&D-oriented sectors		*200-499*	
				Over 500	
Total (SERF)	100.0		100.0		100.0

Legenda: see table 1.

Source: ISTAT: CIS, IPL.

Tab.13 - Decomposition of the nominal growth rate of sales in domestic and foreign components (1). 1990-92.

		(A) TOTAL SALES				(B) DOMESTIC SALES				(C) EXPORTS				(D) = (C)/(A)			
		1990	1991	1992	1990-92	1990	1991	1992	1990-92	1990	1991	1992	1990-92	1990	1991	1992	1990-92
INNOVATING FIRMS	20-199	9.80	5.37	8.36	8.46	6.54	3.65	5.55	5.66	3.26	1.72	2.81	2.80	0.33	0.32	0.34	0.33
	200-499	8.77	5.46	6.77	7.49	6.79	4.09	3.98	5.27	1.98	1.38	2.79	2.22	0.23	0.25	0.41	0.30
	Over 500	5.72	4.27	-0.52	3.22	4.49	2.16	-1.38	1.75	1.22	2.10	0.86	1.47	0.21	0.49	-1.67	0.46
	Total	7.27	4.69	2.68	5.11	5.46	2.79	1.07	3.22	1.82	1.91	1.61	1.89	0.25	0.41	0.60	0.37
NON INNOVATING FIRMS	20-199	7.25	2.21	4.61	4.89	6.06	1.24	3.01	3.57	1.19	0.96	1.59	1.32	0.16	0.44	0.35	0.27
	200-499	1.44	9.00	-4.23	1.96	1.00	5.67	-1.74	1.61	0.44	3.33	-2.48	0.36	0.31	0.37	0.59	0.18
	Over 500	-4.72	-0.34	4.68	-0.20	-6.19	4.83	3.18	0.48	1.47	-5.17	1.50	-0.68	-0.31	15.21	0.32	3.38
	Total	5.80	2.60	3.50	4.12	4.68	1.74	2.34	3.02	1.12	0.86	1.16	1.10	0.19	0.33	0.33	0.27
SERF	20-199	8.14	4.86	6.57	6.95	6.50	3.30	4.39	5.02	1.63	1.56	2.18	1.93	0.20	0.32	0.33	0.28
	200-499	7.39	3.76	3.49	5.11	5.76	3.35	2.12	3.91	1.63	0.41	1.37	1.20	0.22	0.11	0.39	0.23
	Over 500	4.66	3.91	-0.10	2.88	4.14	2.55	-1.07	1.88	0.53	1.36	0.98	1.00	0.11	0.35	-10.24	0.35
	Total	6.58	4.22	3.69	5.06	5.39	2.92	2.10	3.61	1.19	1.31	1.58	1.45	0.18	0.31	0.43	0.29

Notes: (1) The decomposition has been done according to the formula:

$$\frac{\Delta S_t}{S_t} = \frac{\Delta D_t}{D_t}\frac{D_t}{S_t} + \frac{\Delta E_t}{E_t}\frac{E_t}{S_t}$$

were S = sales, D= domestic sales and E = exports.

Source: Istat: CIS, IPL.

Tab. 14 - Summary of regression analysis.

Statistical significativity of coefficients

Dep.var.s	*Coefficients*				*Global model*	
	b0	b1	b2	b3	F	R2
Y1	xxxx	xxxx (+)	xxx (-)	xxxx	xxxx	0.012
Y2	xxxx	xxx (+)	NS (-)	xxxx	xxxx	0.004
Y3	NS	NS (+)	NS (-)	NS	NS	0.002
Y4	xxxx	NS (+)	NS (-)	NS	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, IPL.

Tab. 15 - Growth rates of employment, hours worked and value added of different types of small firms IF (1). 1990-92.

n.	TYPES of IF	Annual rates of growth of employment	Annual rates of growth of hours worked	Annual rates of growth of value-added (in nominal terms)	Annual growth rate of per-capita productivity (in nominal terms)	Annual growth rate of per-hour productivity (in nominal terms)
1	*R&D-based*	4.53	2.12	12.16	7.63	10.04
2	*R&D-intensive 1*	1.97	-2.36	7.79	5.83	10.15
3	*R&D-intensive 2*	4.10	0.58	10.82	6.72	10.24
4	*Occasional R&D-based*	1.33	-0.05	7.71	6.38	7.76
5	*Design-based*	2.06	1.59	9.05	6.99	7.46
6	*Licenses-based*	2.57	0.07	9.94	7.37	9.87
7	*Investment-based*	2.14	0.71	9.53	7.39	8.81
	All firms	2.98	1.08	10.36	7.38	9.28

Notes: (1) 5230 firms.

Source: Istat: CIS, IPL.

Tab. 16 - Export and investment performance of different types of small IF (1). 1990-92

n.	TYPES of IF	Exports/ Sales 1992	Distribution of exports (column %) 1992	*[Distribution of value-added (column %) 1992]*	Annual growth rates of exports (nominal terms) 1990-92	Investment/ value-added (1) 1992	Annual growth rates of investment (2) (nominal terms) 1990-92
1	*R&D-based*	0.30	55.8	*46.3*	15.08	0.11	7.31
2	*R&D-intensive 1*	0.29	2.7	*3.0*	6.46	0.15	6.72
3	*R&D-intensive 2*	0.30	0.2	*0.2*	30.24	0.24	33.06
4	*Occasional R&D-based*	0.23	12.5	*13.6*	10.73	0.11	5.02
5	*Design-based*	0.25	5.8	*6.0*	8.12	0.18	28.35
6	*Licenses-based*	0.17	1.5	*2.2*	-2.60	0.11	6.60
7	*Investment-based*	0.18	21.5	*28.6*	10.71	0.14	10.57
	All firms	0.25	100.0	*100.0*	12.46	0.13	9.31

Notes:
(1) 5230 firms.
(2) Gross investment in machinery.

Source: Istat, CIS, IPL.

Tab.17 - Gaps between the annual rates of growth of employment and hours worked in IF, NIF. 1990-92.

		1990	1991	1992	1990-92
INNOVATING FIRMS	Total	2.83	3.10	0.29	2.01
	Excl.Car industry	*2.08*	*2.39*	*-0.21*	*1.37*
	Non R&D-oriented sectors	0.40	2.32	-0.68	0.67
	R&D-oriented sectors	4.41	3.36	1.09	2.88
	Excl.Car industry	*3.49*	*2.41*	*0.42*	*2.01*
SIZE	20-199	2.02	1.54	1.69	1.81
	200-499	2.67	2.68	0.02	1.76
	Over 500	3.52	3.91	0.11	2.36
	Excl.Car industry	*2.30*	*2.96*	*-0.88*	*1.73*
NON INNOVATING FIRMS	Total	0.64	0.77	1.25	0.88
	Non R&D-oriented sectors	0.70	0.49	0.80	0.65
	R&D-oriented sectors	0.44	1.59	2.63	1.54
SIZE	20-199	0.63	0.96	1.85	1.14
	200-499	1.52	0.04	-2.91	-0.45
	Over 500	-0.21	-0.99	-0.70	-0.60
SERF	Total	2.09	1.78	0.58	1.45
	Excl.Car industry	*1.73*	*1.30*	*0.38*	*-0.38*
	Non R&D-oriented sectors	0.92	0.74	0.28	0.63
	R&D-oriented sectors	3.53	2.87	1.21	2.46
	Excl.Car industry	*2.91*	*2.06*	*0.82*	*1.86*
SIZE	20-199	1.37	1.22	1.61	1.42
	200-499	1.80	1.45	-0.09	1.01
	Over 500	3.81	2.57	0.01	0.40
	Excl.Car industry	*3.16*	*1.37*	*-0.81*	*1.12*

Legenda: see table 1.

Source: Tab.s 2 and 3.

Tab. 18 - 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				
WORK.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.

Tab. 19 - Result of cluster analysis on small firms. Values of the variables employed in the analysis.

n.	Types of IF	n.of firms	Average size	Tipology of R&D: Continuous	Occasional	Absent	R&D/sales %% [1992]	Investment/sales %%	Innov.costs/sales %%
1	*R&D-based*	1690	85	0.99	0.00	0.01	23.3	26.2	31.5
2	*R&D-intensive 1*	190	58	0.85	0.04	0.11	102.8	105.6	166.1
3	*R&D-intensive 2*	24	40	0.71	0.21	0.08	414.8	162.8	428.8
4	*Occasional R&D-based*	890	55	0.00	1.00	0.00	13.4	36.5	22.4
5	*Design-based*	400	58	0.13	0.09	0.78	3.8	27.8	38.1
6	*Licenses-based*	103	64	0.27	0.13	0.60	10.1	30.2	32.5
7	*Investment-based*	2031	52	0.00	0.00	1.00	0.0	77.5	8.9
	All firms	5329	64	0.36	0.18	0.46	15.6	52.0	28.5
	Coefficient of variation (1)			*0.36*	*2.59*	*0.93*	*0.39*	*0.45*	*0.45*

n.	Types of IF	Distribution of innovation costs (%): R&D	Licenses	Industrial design	Trial production	Marketing	Shares of sales (%): Not innovated sales	Process innovations	Product innovations
1	*R&D-based*	53.0	1.6	17.9	20.3	5.6	38.0	21.8	40.2
2	*R&D-intensive 1*	48.3	1.5	23.7	19.6	6.4	32.6	21.1	46.3
3	*R&D-intensive 2*	56.0	1.3	16.6	17.4	8.8	33.8	22.9	43.3
4	*Occasional R&D-based*	47.3	1.8	18.7	23.3	6.2	41.2	26.4	32.4
5	*Design-based*	4.4	1.1	87.3	5.6	1.6	38.3	28.9	32.9
6	*Licenses-based*	10.0	74.0	7.1	7.5	1.4	41.8	30.5	27.7
7	*Investment-based*	2.79	0.8	5.9	14.3	5.5	39.5	40.1	20.4
	All firms	28.3	2.7	18.7	17.1	5.3	39.0	30.2	30.8
	Coeff. of variation (1)	*0.74*	*13.58*	*2.08*	*0.47*	*0.48*	*0.04*	*0.20*	*0.19*

Notes: (1) Standard deviation/average

Source: Istat: CIS

Fig.1 - Average annual growth rates of employment and hours worked. 1990-92

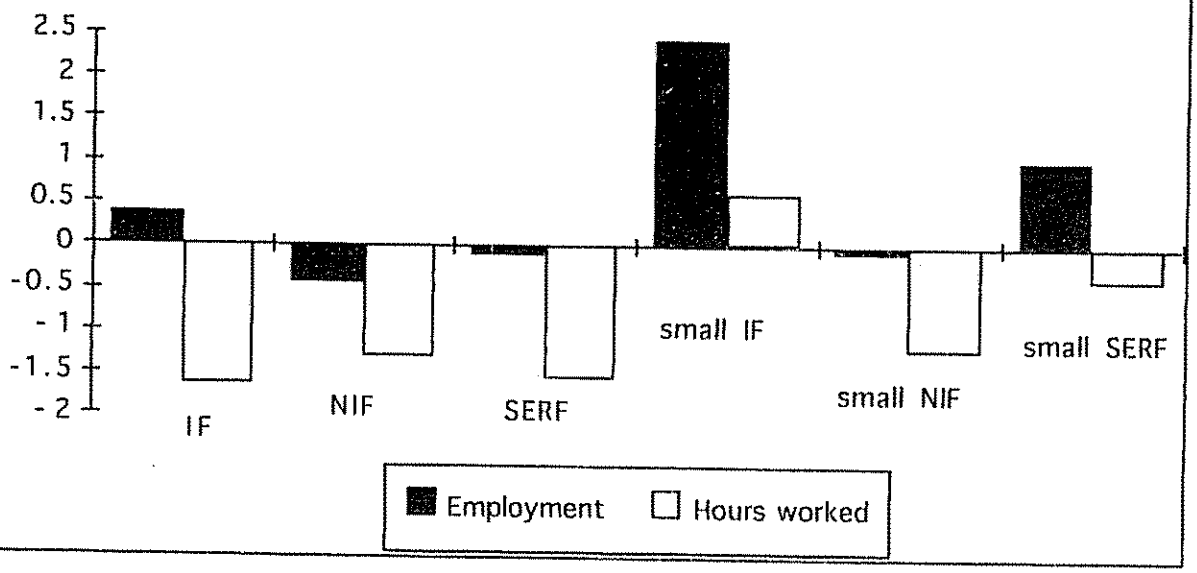
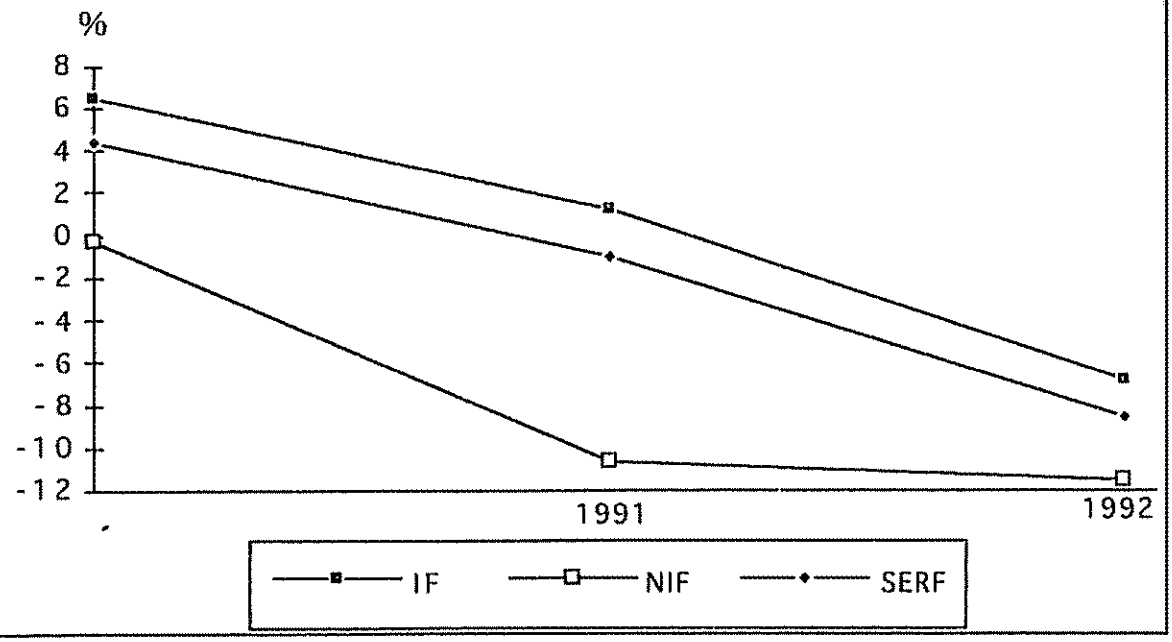


Fig.2 - Annual rates of change of investment. 1990-92.



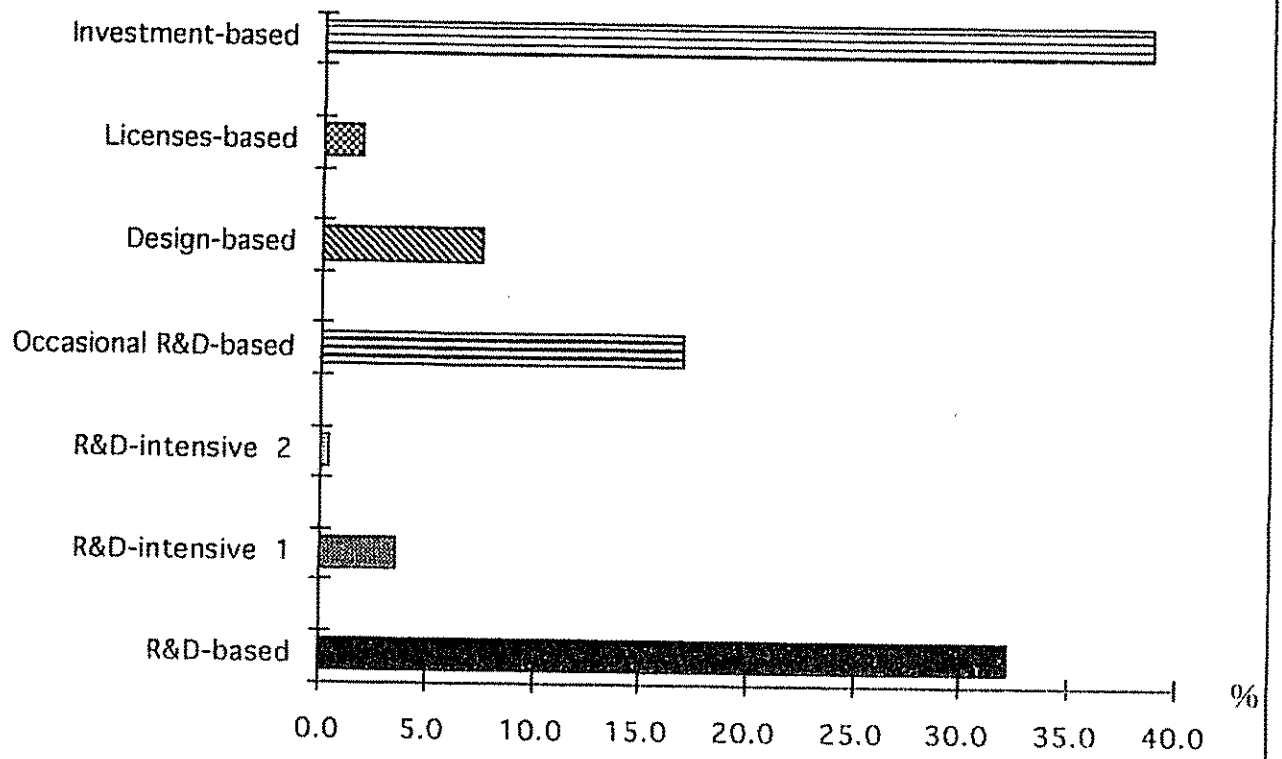
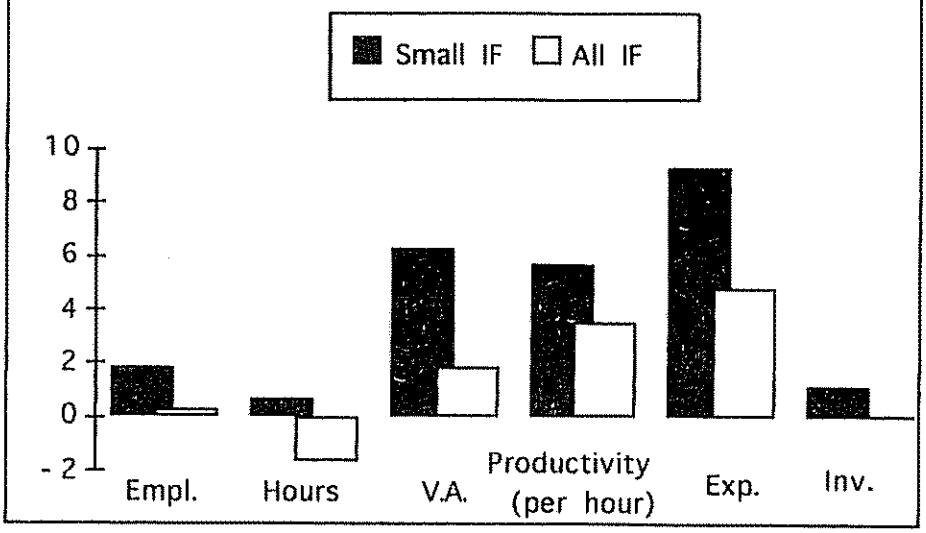


Fig.3 - Types of small innovating firms

Fig.4 - Performance indicators of IF. Average annual rates of change over 1990-92.



References

Archibugi, D., Cesaratto, S. and Sirilli, G. (1991), "Sources of Innovative Activities and Industrial Organization in Italy", *Research Policy*, 20.

Archibugi, D., Cohendet P., Cristensen A. and Schaffer K.A.(1995), *Evaluation of the Community Innovation Survey*, IKE Group, Aalborg, Srint/Eims Report.

Banca d'Italia, *Annual Reports*, various years, Rome.

Bettio, F. (1988), *The Sexual Division of Wage Labour: The Italian Case*, Oxford University Press.

Blanchflower, D. and Burgess, S. (1996), "New Technology and Jobs: Comparative Evidence from a Two Country Study, Centre for Economic Performance", Discussion paper n.285, London School of Economics.

Boyer, R. (1988), "New Technologies and Employment in the 1980s: From Science and Technology to Macroeconomic Modelling", in J.A.Kregel et al., *Barriers to Full Employment*, St.Martin's Press, New York.

Caminati, M. (1986), "Technical Innovations, Life of Equipment and Effective Demand", *Political Economy*, 2, 115-135.

Cesaratto, S. (1995), "Crescita, progresso tecnico e risparmio nella teoria marginalista: un'analisi critica", Working Papers, Dipartimento di economia pubblica, La Sapienza - Roma, forthcoming in G.Mongiovi, F.Petri (eds.), *Value, Distribution and Capital: Essays in Honour of Pierangelo Garegnani*, Routledge, 1997.

Cesaratto, S. (1996), "Alternative Perspectives on Division of Labour, Structural change and Economic Growth", in C.De Bresson (ed): *Innovation and Interdependence: Input-Output Analyses of Innovation*, Edward Elgar.

Cesaratto, S., Mangano, S. and Sirilli, G. (1991), "The Innovative Behaviour of Italian Firms: A Survey on Technological Innovation and R&D", *Scientometrics*, vol. 21 (published also in *Science, Technology and Industry Review*, OECD, 1992).

Cesaratto, S. and Mangano, S. (1993), "Technological Profiles and Economic Performance in the Italian Manufacturing Sector", *Economics of Innovation and New Technology*.

Cesaratto, S., Serrano, F. and Stirati, A. (1995), "Note su disoccupazione tecnologica e interpretazioni dell'attuale elevata disoccupazione", *Quaderni di Economia del lavoro*, 52, pp.23-57.

Cesaratto, S., Stirati, A., Mangano, S. and Serrano, F. (1996), *The impact of innovation on employment. Alternative interpretations and results of the Italian Community Innovation Survey*, European Innovation Monitoring System, EU DG13.

Contini, B. and Monducci, R. (1995), "Analisi economica del sistema delle imprese nella statistica ufficiale: Problemi e prospettive", XXXVI Riunione della Società Italiana degli Economisti, Firenze.

Freeman, C., Clark, J. and Soete, L. (1982), *Unemployment and Technical Innovation. A Study of Long-Waves and Economic Development*, Frances Pinter, London.

Freeman, C. (1995), "Innovation in a new context", *STI-Review*, n.15, 49-74.

Geroski, P. and Walters, C. (1995), "Innovative Activity over the Business Cycles", *Economic Journal*, 105.

Griliches, Z. (1988), "Productivity Puzzles and R&D: Another Non-explanation", *Journal of Economic Perspectives*, 2, 9-21.

ISTAT (1995), *Rapporto paese 1995*, Roma.

OECD (1994), *Jobs Study, Evidence and explanations*, Paris.

OECD (1995), Conference on the Effects of Technology on Firm Performance and Employment: Summary Report, DSTI/IND/STPICCP(95)9.

Pavitt, K. (1982), Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory, *Research Policy*, 13, 343-73.

Pianta, M. (1996), "L'innovazione nell'industria italiana e i suoi effetti economici e occupazionali", *Economia e Politica Industriale*, 47.

Pianta, M., Evangelista, E. and Perani, G. (1996) "The Dynamics of Innovation and Employment: An International Comparison", *STI Review*, June.

Ricardo, D. (1821), *The Principles of Political Economy and Taxation*, in P.Sraffa (ed, 1951) *The Works and Correspondence of David Ricardo*, vol. I, Cambridge University Press.

Schmookler, J. (1966), *Invention and Economic Growth*, Harvard University Press, cambridge (Ma).

Sengenberger, W. and Wilkinson, F. (1995), "Globalization and Labour Standards", in J.Michie, J.G.Smith (eds.), *Managing the Global Economy*, Oxford University Press, Oxford.

Serrano, F. (1995), "Long Period Effective Demand and the Sraffian Supermultiplier", *Contributions to Political Economy*, 14, 67-90

Serrano, F. (1996), *The Sraffian Supermultiplier*, unpublished Ph.D. thesis, University of Cambridge.

Sraffa, P. (1960), *Production of Commodities by Means of Commodities. Prelude to a Critique of Economic Theory*, Cambridge University Press.

Stirati, A. and Cesaratto, S. (1995), "The Italian PhD ten years on", *Higher Education*.

Appendix 1

The figures presented in table 3 show a divergence between the average growth rates of employment and hours worked. While total hours worked fall each year (with the exception of NIF in 1990), employment rises (or falls more moderately) in 1990 and 1991 (with the exception of NIF in 1991). Table 17 shows the difference between the two indicators. The divergence is more marked for IF and SERF. The gap is generally reduced once the car industry is excluded.

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

Table 18 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 also correlate strongly with variations of value added. Hence we find confirmation of the expectation that at the 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.

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 generally 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 trough 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 hiring

(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 overtime and lay-offs, thereby reducing total hours worked. Whereas the increase in employment through new hirings and the reduction in worked hours are visible in 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 overtime and temporary lay-offs but, increasingly, by making workers (some of whom were previously laid off) redundant.[36]

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 para.3.2, according to which in IF and SERF the share of white-collar workers in the total labour-force increased by about 1.5% over the period 1989-1992, and to a lesser measure (0.7%) in NIF. This may be due to the fact that employment of blue-collar workers tends to change more over the cycle, or to structural change in the composition of the labour force - but 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 can be indeed regarded as a proxy for changes in employment when we consider that (a) they include overtime - hence their changes may not reflect changes in actual employment of blue-collar workers and (b) they do not include white collar hours worked. In order to discuss these problems let us look again at table 18, which shows the Spearman correlation coefficients between the variables we are concerned with.

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

The main problem concerning question (b) is the possibility of the existence of some systematic tendency for employment of white and blue-collar workers

to move in the 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 firm 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 firms 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. The negative sign for small firms in SERF seems to be attributable to the fact that white and blue-collar employment in this class tend to move independently of each other rather than to any systematic pattern of 'substitution' of white for blue-collar workers. As white-collar employment accounts for 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, 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 indicated by the National Accounts (see bottom of table 3).

Appendix 2

Description of the statistical approach adopted in section 6.

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 for 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[37];

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, we followed a standard procedure to apply Factor analysis to synthesise the number of variables, and then Cluster analysis to synthesise the innovative behaviour of business units.

The first seven factors or principal components explain 73.6% of the variability, and each can be interpreted as explaining one or more of the original variables. On the basis of these factors, cluster analysis has been 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 was selected on the basis of two tests (PSEUDO F and Cubic Clustering Criterion). The selection of a 'global optimum' number would have resulted in too large a number of groups. 7 clusters were selected. Table 19 shows the value taken by each of the original 15 variables in each cluster.