UNIVERSITÀ POLITECNICA DELLE MARCHE

DIPARTIMENTO DI ECONOMIA

SECTOR POTENTIALITY AND SOURCES OF GROWTH. AN ANALYSIS OF STRUCTURAL CHANGES IN ITALY IN THE NINETIES

ANDREA BONFIGLIO

QUADERNO DI RICERCA n. 237

Giugno 2005

Sector Potentiality and Sources of Growth. An Analysis of Structural Changes in Italy in the Nineties

Andrea Bonfiglio*

Abstract

The objective of this article is to analyse structural changes which occurred in Italy in the period 1992-2000. The analysis is carried out within the I-O framework by the use of multipliers, I-O elasticities, structural decomposition and causative approaches. These tools are used to assess over time the degree of sector interrelationships, the potentiality of sectors in fostering economic growth, the sources of change in the economy and contribution of sectors to growth. In particular, the structural decomposition approach is based on the use of a revised version of RAS finalised to isolate productivity and substitution effects affecting technology changes. From the analysis, there emerges that, in the nineties, the process of development has led to reinforcement of sectors more related to service supply and to an increasing reduction of the importance of agriculture and manufacturing sectors. Moreover, Italy has been interested by structural changes mainly due to the variation of the level of final demand, in particular of consumption, rather than technological changes. Finally, the Italian economy, in line with the general tendency of other industrialised countries, has been involved by the process of rising diffusion and importance of computer and communication technologies throughout the whole economy.

Keywords: structural changes, input-output framework, multipliers, I-O elasticities, decomposition analysis, left causative matrix
J.E.L. Classification: C63, C67, D57, O11, O39

---

* Department of Economics, Faculty of Economics "G. Fuà", Polytechnic University of the Marche, Piazzale Martelli, 8, 60121 Ancona. Tel.: +39 071 2207116, Fax.: +39 071 2207102, e-mail: bonfiglio@dea.unian.it. I am grateful to an anonymous referee for remarks and suggestions on a previous version of the paper.

Contents

1 Introduction

There are several measures that can be used to evaluate structural economic changes. A popular and effective tool to analyse structural changes over time is given by the input-output framework thanks to its peculiar characteristic of depicting analytically a given economic structure. Within this framework, multipliers, I-O elasticities, decomposition analysis and causative approach represent useful instruments to analyse over time the degree of sector interrelationships, the potentiality of sectors in fostering economic growth, the sources of change in an economy and contribution of sectors to growth.

The objective of this paper is to analyse structural changes in Italy in the period 1992-2000 by an I-O approach.

The Italian territory covers 9% of the EU-15 one and concentrates 15% of population (Tab. 1). In 2000 the overall employment amounted to 21 million of workers, representing 13% of EU-15 employment. Sectors with higher levels of employment were trade, business services, public, social and personal services and education. The GDP was about 1.2 euro thousand million, which is 14% of the European GDP. Most GDP was produced by the following sectors: trade, real estate and rental, business services and transportation and communications. The GDP per capita, expressed in PPS, was about 23 thousand, 1.3% bigger than the European average whereas labour productivity, amounting to 55 euro thousand per employed, was 3% bigger than the European average.

The Italian economy is characterised by the persistence of a peculiar development model started in sixties. This model shows a massive presence of small-medium firms, strong dependence on outside economies with reference to requirements of raw materials for industry and high specialization in traditional sectors having low intensity of technological innovation and high labour intensity, such as textile and leather and

shoes. To sustain production of traditional sectors, Italy has increasingly specialized in a more modern sector i.e. the machinery sector, in which it gained relative success (Onida, 1978; de Nardis, 1997; Guerrieri and Rossi, 2000).

The paper is organized as follows. The next section will be dedicated to illustrate all the measures used to perform the structural change analysis. The third section presents the results of the analysis. Finally, the last section reports some concluding remarks.

Tab. 1 – National profile, 2000

	Italy	EU-15
Total area (km^2)	301,230	3,235,994
Population (inhabitants)	57,762,100	376,956,300
Density of population (per km^2)	192	117
Employment (employees)	21,079,750	159,370,000
Agriculture (%)	4.9	4.3
Industry (%)	29.6	29.0
Services (%)	65.5	66.7
Unemployment rate (%)	10.1	7.6
Gross domestic product (€ million)	1,166,548	8,572,162
Agriculture (%)	2.8	2.1
Industry (%)	27.9	27.9
Services (%)	69.4	70.0
Gross domestic product per capita (PPS*)	22,960	22,660
Labour productivity (€)	55,340	53,788

* PPS (Purchasing Power Standards): artificial common currency which eliminates differences in price levels between countries. Calculation on a per head basis allows the comparison of economies significantly different in absolute size.

Source: ISTAT; EUROSTAT database

2 Methodology and data

Several tools aimed at investigating structural changes in Italy are adopted. They are multipliers, I-O elasticities, the structural decomposition approach (SDA) and the causative approach.

Multipliers are employed to measure the degree of sector interrelationship and to identify those sectors which might contribute significantly to economic growth.

I-O elasticties, taking account of the size of sectors, estimate actual potentiality of sectors to favour economic expansion and can thus help policy makers to identify targets for growth.

SDA is used to identify the sources of output change. In particular, it is employed, firstly, to decompose output variation in the two main changes attributable to technology and final demand effects. Then, it is used to track both the causes which explain the part of output change due to technological effect, distinguishing productivity, substitution and sector specific effects, and the causes which produce the remaining part of output change induced by the final demand effect, distinguishing level, product mix and category effects.

Finally, the causative approach is employed to identify changes of sector contribution to output impacts by calculating the left causative matrix.

The tables used to analyse structural changes are the 1992 and 2000 national I-O tables. They are both constructed by ISTAT following the European System of Accounts 1995 (ESA). The 1992 table is made up of 92 sectors and has been constructed directly whereas the most recent one depicts 60 sectors and has been derived from the 2000 supply and use tables (Mantegazza and Mastrantonio, 2003; Mantegazza *et al.*, 2004). They are both expressed in basic and current prices and they report total flows, meaning domestic plus imported intermediate inputs. To make the

comparison meaningful and manageable, maintaining a sufficient level of detail, both tables have been aggregated into 28 sectors. Finally, in order to exclude the impact of the price factor, the 1992 28-sector table was inflated to 2000 prices using GDP inflators.

2.1 I-O Multipliers and Elasticities

Multipliers are well-known concepts in the input-output analysis. They permit to measure overall impacts generated by injection of one additional unity of final demand (in the case of demand-driven models) taking account of both direct effects in the sector whose final demand changed and indirect effects (and, by a simple extension, even those induced) produced by backward linkages with the other sectors (Miller and Blair, 1985). Multipliers are not only used to estimate impacts, for example of a given policy, but also to quantify the degree of sector interdependence of a given economy and to identify those sectors (the so-called key sector) which might contribute significantly to economic growth. This research focuses on three types of multipliers which are used usually: output, employment and value added multipliers. These latter estimate overall impact in terms of output, employment and value added produced by a variation of one final demand unit, respectively. They take the following form: $\mathbf{om} = \mathbf{e}'(\mathbf{I} - \mathbf{A})^{-1}$; $\mathbf{em} = \mathbf{e}'\left[\hat{\mathbf{l}}(\mathbf{I} - \mathbf{A})^{-1}\right]$; $\mathbf{hm} = \mathbf{e}'\left[\hat{\mathbf{h}}(\mathbf{I} - \mathbf{A})^{-1}\right]$. Note that $\mathbf{e}'$ is the row unit vector; $(\mathbf{I} - \mathbf{A})^{-1}$ is the Leontief inverse; $\hat{\mathbf{l}}$ is the diagonal matrix of employment coefficients obtained by dividing sector employment by sector output; $\hat{\mathbf{h}}$ is the diagonal matrix of value added coefficients obtained by dividing sector value added by sector output.

Multipliers neglect the size of the sectors. This implies that a sector with a bigger multiplier in the economy may be so small that it takes an unrealistic rate of growth to generate the same growth as a very large sector with a very small multiplier. Therefore, if the objective is to

identify targets for growth, other measures which take account of the importance of sectors should be introduced. I-O elasticities, conceived by Mattas and Shrestha (1991), serve this scope.

I-O elasticities show the percentage change in total output, employment or value added of the economy induced by percentages changes in the final demand of any sector. They takes the following form: $\mathbf{oe} = \mathbf{e}'(\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{f}}$; $\mathbf{ee} = \mathbf{e}'\left[\hat{\mathbf{l}}(\mathbf{I} - \mathbf{A})^{-1}\right]\hat{\mathbf{f}}$; $\mathbf{he} = \mathbf{e}'\left[\hat{\mathbf{h}}(\mathbf{I} - \mathbf{A})^{-1}\right]\hat{\mathbf{f}}$. Note that $\hat{\mathbf{f}}$ represents the diagonal matrix of ratios between final demands and total output (expressing the size of the sectors), i.e. fd_i/x with $i = 1,...,n$ (where n is the number of the sectors).

2.2 Decomposing structural changes

The structural decomposition approach (SDA) is a method which, comparing the same economy in different time-periods, allows assessing structural changes which happened in the economy over time. The basic idea is that change over time in a given variable can be decomposed into changes in its determinants. From a policy analysis standpoint, SDA offers two main advantages (Chenery, 1979). First, it permits to assess and confront different development strategies over time. Second, it allows identifying the relative importance of the various sources of growth. SDA results to be widely used to identify the underlying sources of the change. Recent contributions are for example: Ciobanu *et al.* (2004), Kagawa and Inamura (2001; 2004), Mukhopadhyay and Chakraborty (2004), Andreosso-O'Callaghan and Yue (2002), Hoekstra and van den Bergh (2002), van der Linden and Hoekstra (2002), Roy *et al.* (2002), Liu and Saal (2001).

In this paper, SDA is used to analyse determinants of change in output, focusing on technological and final demand sources. The approach followed is that of van der Linden and Dietzenbacher (2000) and van der Linden and Hoekstra (2002). Recalling the basic formulation of input-

output analysis, a standard system of input-output relationships can be expressed as: $\mathbf{x} = \mathbf{Ax} + \mathbf{y}$, where $\mathbf{x}$ is output vector, $\mathbf{A}$ is the matrix of I-O coefficients and $\mathbf{y}$ is final demand vector. The solution of the system is: $\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y}$ or, for sake of convenience, $\mathbf{x} = \mathbf{By}$, where $\mathbf{B} = (\mathbf{I} - \mathbf{A})^{-1}$ denotes the Leontief inverse. The change in output $\Delta\mathbf{x}$ can be decomposed in various equivalent forms which increase as the number of determinants exceeds two. Two equivalent polar forms are: $\Delta\mathbf{x} = (\Delta\mathbf{B})\mathbf{y_0} + (\Delta\mathbf{B})\mathbf{y_1}$ and $\Delta\mathbf{x} = \mathbf{B_0}\Delta\mathbf{y} + \mathbf{B_1}\Delta\mathbf{y}$. We adopt the average of both expressions obtaining:

$$\Delta\mathbf{x} = \frac{1}{2}(\Delta\mathbf{B})(\mathbf{y_0} + \mathbf{y_1}) + \frac{1}{2}(\mathbf{B_0} + \mathbf{B_1})(\Delta\mathbf{y}) \tag{1}$$

The first addend on the right hand side measures that part of change in output due to a technology change while final demand remains unchanged. Conversely, the second addend measures that part of change in output caused by a final demand variation assuming technology does not vary.

2.2.1 Decomposing technology change

The objective of this section is to investigate on the causes of technology change measured by the first term of equation (1). To this aim, the change in the matrix of I-O coefficients, $\Delta\mathbf{A} = \mathbf{A_1} - \mathbf{A_0}$, is further decomposed in three components: changes in productivity of primary inputs or also in the intensity of use of intermediate inputs (productivity effect), changes due to substitution among intermediate inputs (substitution effect) and, finally, changes which have specifically interested the sector examined, or rather, which cannot be explained by the other effects (specific sector effect).

These components are measured by applying a revised version of the RAS technique (Stone, 1961) applied to an old matrix to estimate a new matrix. The RAS technique estimates technical coefficients as follows:

$$\tilde{\mathbf{A}}_1 = \hat{\mathbf{r}}\mathbf{A}_0\hat{\mathbf{s}}\,, \tag{2}$$

where $\mathbf{A_0}$ represents the initial matrix whereas $\hat{\mathbf{r}}$ and $\hat{\mathbf{s}}$ are diagonal matrices of multipliers r_i and s_j, obtained in such a way that the following constraints are satisfied:

$$\begin{aligned} &\hat{\mathbf{r}}\mathbf{A_0}\hat{\mathbf{s}}\mathbf{x_1} = \mathbf{u_1} \\ &\mathbf{e}'\hat{\mathbf{r}}\mathbf{A_0}\hat{\mathbf{s}}\hat{\mathbf{x}}_\mathbf{1} = \mathbf{v}_\mathbf{1}'\,. \end{aligned} \tag{3}$$

Note that $\mathbf{u_1}$ and $\mathbf{v}_\mathbf{1}'$ are respectively the column vector of intermediate sales and the row vector of intermediate purchases of the new I-O table.

Properties and conditions of convergence and uniqueness related to the RAS technique have been widely discussed in several studies (see for example Bacharach, 1970; Lecomber, 1975).

The economic interpretation of row and column multipliers is well-known. Row multipliers would take account of the substitution effect since a proportional increase or decrease of all row coefficients represents substitution of inputs caused by price differences. Instead column multipliers would take account of the so-called fabrication effect (Stone and Brown, 1962), since they reduce or increase needs for primary inputs and, thus, value added, by modifying uniformly needs for intermediate inputs. This last effect can be also defined as productivity effect since a reduction (an increase) in needs for primary inputs corresponds to a decrease (a rise) in the quantity of primary inputs necessary to produce one output unit.

Once accepted this economic interpretation, row and column multipliers can be then used to decompose the change in technology into substitution and productivity effects.

In general, if r_i is less than one, on average, sectors have reduced the use of the intermediate input i, substituting this latter with another one because of an increase in the relative price of input i. In the same way, if r_i is bigger than one, the use of the intermediate input i has been on average increased by sectors since input i has become relatively cheaper. As for column multipliers, if s_j is less than one, the intensity of use of intermediate inputs from sector j has decreased revealing an increase in the share of primary inputs used by sector j and thus a decline in productivity of primary inputs. In the same way, if s_j is bigger than one, the intensity of use of intermediate inputs from sector j has increased showing an increase in productivity of primary inputs.[1]

However, two questions have to be solved. The first one is that a unique solution for the multipliers does not exist. If r_i and s_j satisfy row and column total constraints, it also true that even λr_i and $\lambda^{-1} s_j$ will satisfy. In addition, it is economically plausible that the sum of all substitution effects should equal zero. This is because the substitution of an input with another should not modify total intermediate use. In other words, total intermediate use should be the same as in the case in which no substitution had happened. Formally, this implies rescaling row multipliers in such a way that the following condition is satisfied:

[1] It should be noted that since r_i and s_j act jointly in modifying I-O coefficients, it is not said that the final effects mirror the direction of multipliers. For instance, r_i can be bigger than one and, in spite of this, intermediate sales of sector i could be diminished because of the joint effect of column multipliers. Similarly, s_j can be bigger than one and at the same time intermediate purchases of sector j could be lower than the previous level because of the opposing effects produced by row multipliers. Moreover there could intervene other specific sector effects which are not captured by column and row multipliers.

$$\frac{\mathbf{r}'\mathbf{A_0}\hat{\mathbf{s}}\mathbf{x_1}}{\mathbf{e}'\mathbf{A_0}\hat{\mathbf{s}}\mathbf{x_1}} = 1 \tag{4}$$

In so doing, a unique solution for multipliers is guaranteed.

The second question is that, as several empirical results have demonstrated, it is improbable that the estimated table by RAS perfectly resembles the actual table. The difference between estimated and actual cells can be then attributed to specific sectoral causes which changes in productivity and substitution process cannot explain.

The sector-specific component is derived as:

$$\mathbf{E} = \mathbf{A_1} - \tilde{\mathbf{A}}_\mathbf{1} = \mathbf{A_1} - \hat{\mathbf{r}}\mathbf{A_0}\hat{\mathbf{s}} \tag{5}$$

Therefore, it results that $\Delta\mathbf{A} = \hat{\mathbf{r}}\mathbf{A_0}\hat{\mathbf{s}} - \mathbf{A_0} + \mathbf{E}$. Considering that $\mathbf{A_0} = \mathbf{I}\mathbf{A_0}\mathbf{I}$, $\Delta\mathbf{A}$ can be decomposed using two equivalent forms:

$$\begin{aligned} \Delta\mathbf{A} &= \hat{\mathbf{r}}\mathbf{A_0}\hat{\mathbf{s}} + \hat{\mathbf{r}}\mathbf{A_0}\mathbf{I} - \hat{\mathbf{r}}\mathbf{A_0}\mathbf{I} - \mathbf{I}\mathbf{A_0}\mathbf{I} + \mathbf{E} \\ \Delta\mathbf{A} &= \hat{\mathbf{r}}\mathbf{A_0}\hat{\mathbf{s}} + \mathbf{I}\mathbf{A_0}\hat{\mathbf{s}} - \mathbf{I}\mathbf{A_0}\hat{\mathbf{s}} - \mathbf{I}\mathbf{A_0}\mathbf{I} + \mathbf{E} \end{aligned} \tag{6}$$

Taking the average value of both expressions and recombining the resulting expression, we obtain:

$$\Delta\mathbf{A} = \frac{1}{2}(\hat{\mathbf{r}} - \mathbf{I})\,\mathbf{A_0}\,(\hat{\mathbf{s}} + \mathbf{I}) + \frac{1}{2}(\hat{\mathbf{r}} + \mathbf{I})\,\mathbf{A_0}\,(\hat{\mathbf{s}} - \mathbf{I}) + \mathbf{E} \tag{7}$$

The first addend refers to that part of change in I-O coefficients induced by substitution effect, the second addend measures the productivity effect and finally, the last addend explains the share of change in I-O coefficients which is not captured by substitution and productivity effects and is therefore attributable to specific sector effects. Since $\Delta\mathbf{B} = \mathbf{B_0}\,(\Delta\mathbf{A})\,\mathbf{B_1}$ and $\Delta\mathbf{B} = \mathbf{B_1}\,(\Delta\mathbf{A})\,\mathbf{B_0}$, taking the average value of both expressions, it results that:

$$\Delta\mathbf{B} = \frac{1}{2}\mathbf{B_0}(\Delta\mathbf{A})\mathbf{B_1} + \frac{1}{2}\mathbf{B_1}(\Delta\mathbf{A})\mathbf{B_0} \tag{8}$$

Substituting equation (7) into equation (8) and this latter into equation (1) the term $\frac{1}{2}(\Delta\mathbf{B})(\mathbf{y_0} + \mathbf{y_1})$ can be rewritten as a sum of the following three components:

$$\frac{1}{8}[\mathbf{B_0}(\hat{\mathbf{r}} - \mathbf{I})\mathbf{A_0}(\hat{\mathbf{s}} + \mathbf{I})\mathbf{B_1} + \mathbf{B_1}(\hat{\mathbf{r}} - \mathbf{I})\mathbf{A_0}(\hat{\mathbf{s}} + \mathbf{I})\mathbf{B_0}](\mathbf{y_0} + \mathbf{y_1}) \tag{9}$$

$$\frac{1}{8}[\mathbf{B_0}(\hat{\mathbf{r}} + \mathbf{I})\mathbf{A_0}(\hat{\mathbf{s}} - \mathbf{I})\mathbf{B_1} + \mathbf{B_1}(\hat{\mathbf{r}} + \mathbf{I})\mathbf{A_0}(\hat{\mathbf{s}} - \mathbf{I})\mathbf{B_0}](\mathbf{y_0} + \mathbf{y_1}) \tag{10}$$

$$\frac{1}{4}[\mathbf{B_0}\mathbf{E}\mathbf{B_1} + \mathbf{B_0}\mathbf{E}\mathbf{B_1}](\mathbf{y_0} + \mathbf{y_1}) \tag{11}$$

In a similar way to equation (7), equation (9) measures that part of output change caused by the substitution effect. Equation (10) measures how much part of output change has been induced by the productivity effect and finally equation (11) measures consequences provoked by specific sectoral effects.

2.2.2 Decomposing final demand change

The aim of this section is to decompose the second term of equation (1) in three components: variation of level of final demand, variation of the product mix of final demands and variation of categorical distribution. Following Dietzenbacher and Los (1998), the variation of final demand, $\Delta\mathbf{y}$, can be expressed in two equivalent polar forms:

$$\begin{aligned}\Delta\mathbf{y} &= (\Delta g)\mathbf{M_0}\hat{\mathbf{d}}_\mathbf{0}\mathbf{e} + g_1(\Delta\mathbf{M})\hat{\mathbf{d}}_\mathbf{0}\mathbf{e} + g_1\mathbf{M}_1\left(\Delta\hat{\mathbf{d}}\right)\mathbf{e} \\ \Delta\mathbf{y} &= (\Delta g)\mathbf{M_1}\hat{\mathbf{d}}_\mathbf{1}\mathbf{e} + g_0(\Delta\mathbf{M})\hat{\mathbf{d}}_\mathbf{1}\mathbf{e} + g_0\mathbf{M_0}\left(\Delta\hat{\mathbf{d}}\right)\mathbf{e}\end{aligned} \tag{12}$$

where:

$\mathbf{M} = \left[m_{ij} \right]$ is the matrix of product mix of final demands, with $i = 1,...,n$; $j = 1,...,h$; h is the number of categories of final demand; $m_{ij} = fd_{ij} \Big/ \sum_{k=1}^{n} fd_{kj}$, where fd_{ij} is the quantity of good or service produced by sector i and sold to the category of final demand j. Note that $\sum_{i=1}^{n} m_{ij} = 1$;

$g = \sum_{i=1}^{n} \sum_{j=1}^{h} fd_{ij}$ is a scalar representing the level of final demand;

$\mathbf{d} = \left[d_j \right]$ is a vector expressing the categorical distribution of final demand, where $d_j = g^{-1} \sum_{i=1}^{n} fd_{ij}$. Note that $\sum_{j=1}^{h} d_j = 1$.

Assigned g, $\mathbf{M}$, $\mathbf{d}$, the vector of final demand can be calculated as $\mathbf{y} = g\mathbf{M}\mathbf{d}$. The single final demand categories can be separated using $g\mathbf{M}\hat{\mathbf{d}}$. In this case, the final demand vector can be obtained as $\mathbf{y} = g\mathbf{M}\hat{\mathbf{d}}\mathbf{e}$. Taking the average form of both expressions in equation (12) and substituting the resulting equation into (1), the second term $\frac{1}{2}(\mathbf{B_0} + \mathbf{B_1})(\Delta\mathbf{y})$ can be rewritten as a sum of the following three components:

$$\frac{1}{4}(\mathbf{B_0} + \mathbf{B_1})(\Delta\mathbf{g})\left(\mathbf{M_0}\hat{\mathbf{d}}_\mathbf{0} + \mathbf{M_1}\hat{\mathbf{d}}_\mathbf{1}\right)\mathbf{e} \tag{13}$$

$$\frac{1}{4}(\mathbf{B_0} + \mathbf{B_1})\left[g_1(\Delta\mathbf{M})\hat{\mathbf{d}}_\mathbf{0} + g_0(\Delta\mathbf{M})\hat{\mathbf{d}}_\mathbf{1} \right]\mathbf{e} \tag{14}$$

$$\frac{1}{4}(\mathbf{B_0} + \mathbf{B_1})(g_1\mathbf{M_1} + g_0\mathbf{M_0})\left(\Delta\hat{\mathbf{d}}\right)\mathbf{e} \tag{15}$$

Equation (13) measures how much part of output change has been caused by a variation of the level of final demand. Equation (14) measures that

part of change in output which can be attributed to a change in the product mix of final demands, and finally, equation (15) gives an estimate of the effect on output produced by a variation of the categorical distribution of final demand.

2.3 Causative matrix

A further approach that allows investigating temporal changes is the causative matrix one, extended to I-O analysis by Jackson *et al.* (1990). This approach is based on the so-called causative matrix which, by interpreting its elements, permits to explain changes between the transition matrix of a given period and the transition matrix of a successive period. The main advantage is the possibility of analysing contribution of sectors with respect to the total economy taking account of the influences of each sector on each other sector. This approach has been recently used by Ciobanu *et al.* (2004) in order to estimate changes in contribution of sectors of the regional economy of East Macedonia and Thrace in North East Greece between 1980 and 1997.

Formally, working on the inverse matrix rather than technical or input coefficients matrix, a transition matrix is obtained by normalising the elements of the inverse by their relative column sums (output multipliers) as follows:

$$\mathbf{K} = \mathbf{B} \times \mathbf{o\hat{m}^{-1}} \tag{16}$$

The transition matrix $\mathbf{K}$ corresponds to a standardised Leontief inverse and allows analysing the contribution of each sector to output multiplier of each other sector. Considering two distinct time periods, t and t+1, the transition matrices corresponding to the two time periods, $\mathbf{K}_{t+1}$ and $\mathbf{K}_t$, are assumed to be linked by a multiplicative relationships as follows:

$$\mathbf{K}_{t+1} = \mathbf{C} \times \mathbf{K}_t \tag{17}$$

where $\mathbf{C}$ represents the left causative matrix. Solving for $\mathbf{C}$ we obtain:

$$\mathbf{C} = \mathbf{K}_{t+1} \times \mathbf{K}_t^{-1} \tag{18}$$

Matrix $\mathbf{C}$ explains changes between the two transition matrices through the analysis of its elements[2]. Note that all column sums equal one. The element c_{ij} measures the influence of sector j on contribution of sector i to output multipliers of all sectors[3]. $c_{ij} < 0$ indicates a reduction of contribution of sector i to output multipliers owing to sector j.

Useful information also derives from comparing on-principal-diagonal elements and row sums to unity and row sums of off-diagonal elements to zero.

If a diagonal element of a given sector is less than one, this will reveal a decreased influence of the corresponding final demand on the contribution of the sector to multipliers and hence a decrease in the capability of the sector of stimulating its output impact provoked by a variation of its own final demand. This last concept can be expressed also saying that the degree of internalisation or endogenization of the final demand impact related to a given sector has decreased. In the same way, a diagonal

---

[2] It is also possible to make a reverse comparison of t with t+1 instead of t+1 with t. In this case, we would have $\mathbf{K}_t = \tilde{\mathbf{C}} \times \mathbf{K}_{t+1}$ where $\tilde{\mathbf{C}}$, the causative matrix for the reverse analysis, is obtained as follows: $\tilde{\mathbf{C}} = \mathbf{K}_t \times \mathbf{K}_{t+1}^{-1} = \mathbf{C}^{-1}$.

[3] This interpretation can be easily comprehended by expressing in analytical form any element of the system (17) as follows: $k_{ij}^1 = c_{i1}k_{1j}^0 + c_{i2}k_{2j}^0 + c_{i3}k_{3j}^0 + ...$. The contribution of sector i to output multiplier of sector j at time 1 is thus expressed as a linear function of all sectors's previous contributions to sector j's output multiplier. The weight c_{ih} can be interpreted as degree of influence of sector h on contribution of sector i to output multiplier of sector j with $j = 1,...,n$.

element more than one would indicate an increase in the level of endogenization of the relative final demand impact.

Row sum of a given sector more than one generally corresponds to an increase in the contribution of the sector to output multipliers when final demands change. Analogously, row sums less than one indicate a decrease in contribution of the corresponding sectors to output multipliers.

Moreover, it is possible to isolate, for any sector, the influence of the other sectors' final demand from the influence of all final demands, computing the sum of the off-diagonal elements. In this case, a value more than zero indicates an increase in the contribution of the sector when only final demands of the other sectors change whereas a value less than zero indicate a decrease in the contribution.

3 Empirical results

This sections reports the results of the analysis of structural changes occurred in Italy in the nineties.

In 1992 secondary sectors showed higher output multipliers (Tab. 1). In particular, sectors with higher backward linkages were leather and shoes, other manufacturing (i.e. furniture, musical instruments, jewellery), textile and machinery. In 2000 there emerges a general increase in output multipliers which mainly involves electricity, gas and water, hotels and businesses, credit and insurance, business services, chemicals and means of transportation. However, several sectors experience a decline of their output multipliers, in particular: electrical and optical equipment, fishing, agriculture, leather and shoes. The sectors having the biggest output multipliers are other manufacturing, machinery, food and tobacco and rubber and plastic products. The output multiplier for other manufacturing indicates that an increase by one € million in the final demand of the sector brings about a rise in output by 2.046 € million. Substantially, some sectors (other manufacturing and machinery) which

in 1992 represented key sectors for the Italian economy maintain their strategic importance while others (leather and shoes and textile) lose positions.

Tab. 1 – Sector I-O multipliers for Italy, 1992-2000

Sectors	Output				Employment*				Value Added			
	1992	Rank	2000	Rank	1992	Rank	2000	Rank	1992	rank	2000	Rank
Agriculture, forestry, hunting	1.546	19	1.410	24	46.7	1	30.7	3	0.839	7	0.738	12
Fishing	1.318	25	1.148	27	27.0	11	12.1	22	0.671	21	0.506	24
Mining	1.183	28	1.118	28	5.0	28	3.0	28	0.301	28	0.197	28
Food and Tobacco	1.947	8	2.024	3	23.5	14	20.1	12	0.636	22	0.666	14
Textile products and apparel	2.005	3	1.988	5	28.3	7	20.8	10	0.700	16	0.639	16
Leather and shoes	2.065	1	1.987	6	28.2	9	19.7	13	0.697	18	0.583	21
Timber and furniture	1.924	10	1.944	10	28.7	6	20.1	11	0.710	15	0.635	17
Paper, printing, publishing	1.951	7	1.978	7	20.0	20	15.7	17	0.722	14	0.630	19
Chemicals	1.638	17	1.767	15	8.1	26	7.9	26	0.372	27	0.388	27
Rubber and plastic products	1.914	11	1.997	4	17.6	21	14.9	20	0.629	23	0.581	22
Products of non-metal minerals	1.947	9	1.896	13	20.5	18	17.6	15	0.747	13	0.690	13
Metal products	1.967	6	1.944	11	21.2	16	15.8	16	0.671	20	0.573	23
Machinery	1.999	4	2.027	2	21.0	17	15.6	18	0.678	19	0.601	20
Electrical and optical equipment	1.771	15	1.599	19	15.6	22	9.9	24	0.572	25	0.412	26
Means of transportation	1.816	13	1.938	12	15.3	23	12.7	21	0.476	26	0.464	25
Other manufacturing	2.030	2	2.046	1	25.6	13	18.3	14	0.699	17	0.633	18
Electricity, gas and water	1.508	21	1.724	16	8.8	25	8.0	25	0.623	24	0.660	15
Construction	1.967	5	1.950	8	25.8	12	24.2	7	0.805	11	0.795	10
Trade	1.560	18	1.582	22	27.5	10	23.6	8	0.860	5	0.832	8
Hotels and businesses	1.754	16	1.950	9	29.2	5	30.6	4	0.820	10	0.887	4
Transportation and communications	1.784	14	1.715	17	20.3	19	15.1	19	0.887	4	0.764	11
Credit and insurance	1.446	24	1.588	20	13.4	24	11.3	23	0.841	6	0.812	9
Real estate and rental	1.269	26	1.304	25	5.8	27	5.9	27	0.922	3	0.982	1
Business services	1.522	20	1.654	18	23.3	15	23.3	9	0.789	12	0.856	6
Public administration	1.500	23	1.497	23	30.7	4	27.7	6	0.926	2	0.909	3
Education	1.188	27	1.229	26	38.5	3	38.4	2	0.976	1	0.966	2
Health	1.885	12	1.881	14	28.2	8	28.6	5	0.836	8	0.855	7
Other services	1.502	22	1.586	21	43.5	2	43.3	1	0.822	9	0.868	5

* Employment multipliers are expressed per one € million

Source: Author's elaboration

Moreover, there should be noted the appearance of food and tobacco and rubber and plastic products among the most important sectors.

With reference to employment, in 1992 the sectors having higher multipliers were: agriculture, other services, education, public administration and hotels and businesses. In 2000 there can be noticed a decrease in almost all employment multipliers as a consequence of a generalised increase in labour productivity. The sectors which are mainly interested by increases in the level of labour efficiency are agriculture,

fishing, timber and furniture, leather and shoes, textile. On the contrary, the only sectors which see to increase their employment multipliers are hotels and businesses and health. Higher employment multipliers are shown by other services, education, agriculture, hotels and businesses and health. The employment multiplier for other services shows that an injection of final demand in the sector amounting to one € million is able to generate an increase in overall employment by about 43 employees.

As regards value added, tertiary sectors were in 1992 those exhibiting higher multipliers. In particular the sectors which showed bigger values were education, public administration, real estate and rental and transportation and communications. Besides tertiary sectors, also agriculture exhibited a significant multiplier especially in comparison with secondary sectors which showed the lowest multipliers. Comparing 1992 value added multipliers with those of 2000, there emerges a general consolidation of tertiary sectors about the capability of generating richness in front of loss of importance of primary and secondary sectors. However this change does not involve all sectors uniformly. In fact, among secondary sectors, there are some which increase their contribution to remuneration of factors of production, such as food and tobacco, chemicals, electricity, gas and water, as well as among those tertiary there appear sectors which, instead, reduce their multipliers, meaning trade, transportation and communications, credit and insurance, public administration and education. Analysing the most important sectors, the first three which had higher value added multipliers in 1992, remain in 2000 the same although the order changes. The most significant sectors are now in decreasing order: real estate and rental, education and public administration. Value added multiplier for real estate and rental indicates that an increase in the final demand of this sector by one € million induces a rise in overall value added by 982 € thousands. It is interesting to note that the transportation and communications sector passes from

the fourth position to the eleventh position and is replaced by hotels and businesses sector which gains six positions.

The problem associated to multipliers is that the latter do not consider the size of the sectors therefore they could provide policy makers with misleading information about real potentiality of sectors in favouring economic growth. For this reason, I-O elasticities are computed. The relevant results are reported in Tab. 2.

Tab. 2 – Sector I-O elasticities for Italy, 1992-2000

Sectors	Output				Employment*				Value Added			
	1992	Rank	2000	Rank	1992	Rank	2000	Rank	1992	rank	2000	Rank
Agriculture, forestry, hunting	0.0137	21	0.0095	24	0.4145	13	0.2060	17	0.0074	17	0.0049	21
Fishing	0.0014	27	0.0014	27	0.0284	27	0.0146	27	0.0007	27	0.0006	27
Mining	0.0003	28	0.0004	28	0.0013	28	0.0010	28	0.0001	28	0.0001	28
Food and Tobacco	0.0716	3	0.0574	5	0.8642	6	0.5692	8	0.0234	8	0.0189	11
Textile products and apparel	0.0457	10	0.0491	8	0.6448	9	0.5128	10	0.0160	11	0.0158	12
Leather and shoes	0.0179	19	0.0199	19	0.2448	17	0.1971	19	0.0061	21	0.0058	20
Timber and furniture	0.0020	26	0.0029	26	0.0305	26	0.0296	26	0.0008	26	0.0009	26
Paper, printing, publishing	0.0106	23	0.0126	21	0.1088	22	0.1005	22	0.0039	23	0.0040	23
Chemicals	0.0315	15	0.0338	14	0.1550	21	0.1516	21	0.0072	19	0.0074	19
Rubber and plastic products	0.0062	25	0.0095	23	0.0572	25	0.0714	24	0.0020	25	0.0028	25
Products of non-metal minerals	0.0071	24	0.0093	25	0.0750	24	0.0865	23	0.0027	24	0.0034	24
Metal products	0.0181	18	0.0252	18	0.1956	20	0.2046	18	0.0062	20	0.0074	18
Machinery	0.0465	7	0.0680	3	0.4887	11	0.5240	9	0.0158	12	0.0201	9
Electrical and optical equipment	0.0445	11	0.0514	7	0.3931	14	0.3187	13	0.0144	14	0.0132	14
Means of transportation	0.0427	12	0.0478	10	0.3594	15	0.3139	14	0.0112	15	0.0114	15
Other manufacturing	0.0256	17	0.0328	15	0.3226	16	0.2927	15	0.0088	16	0.0101	16
Electricity, gas and water	0.0136	22	0.0111	22	0.0797	23	0.0513	25	0.0056	22	0.0043	22
Construction	0.0976	2	0.0751	2	1.2808	2	0.9322	2	0.0399	2	0.0306	3
Trade	0.1205	1	0.1179	1	2.1260	1	1.7613	1	0.0664	1	0.0620	1
Hotels and businesses	0.0419	13	0.0439	12	0.6977	8	0.6883	7	0.0196	10	0.0200	10
Transportation and communications	0.0464	8	0.0534	6	0.5277	10	0.4707	11	0.0231	9	0.0238	7
Credit and insurance	0.0458	9	0.0469	11	0.4247	12	0.3345	12	0.0267	7	0.0240	6
Real estate and rental	0.0474	6	0.0422	13	0.2154	19	0.1905	20	0.0344	4	0.0318	2
Business services	0.0143	20	0.0172	20	0.2193	18	0.2414	16	0.0074	18	0.0089	17
Public administration	0.0572	5	0.0484	9	1.1716	3	0.8958	3	0.0353	3	0.0294	4
Education	0.0336	14	0.0278	16	1.0903	4	0.8700	5	0.0276	6	0.0219	8
Health	0.0678	4	0.0580	4	1.0134	5	0.8831	4	0.0301	5	0.0264	5
Other services	0.0282	16	0.0271	17	0.8184	7	0.7413	6	0.0155	13	0.0148	13

* Employment I-O elasticities are expressed per one € million

Source: Author's elaboration

In 1992 the first two sectors which showed the highest potential to generate total output, employment and value added were trade and construction. For instance, output and value added elasticities for trade indicated that an increase in final demand of this sector by 10% was able

to stimulate a growth of output by 12% and a rise in value added by 0.6%.

Roughly, sectors with the highest potential were mainly tertiary sectors and included, besides construction, some secondary sectors such as food and tobacco, at levels of all impact variables, machinery, in terms of output, and textile, in terms of employment.

During the nineties, in line with that which is noticed in terms of multipliers, almost all employment elasticities tend to decrease. Exceptions are given by rubber and plastic products, manufacturing of non-metal minerals, metal products, machinery and business services.

A further common result is that primary sector tends to reduce its importance in terms of all the impact variables. Instead, a contrasting finding is that most secondary sectors (especially machinery) strengthen their potential, while tertiary sectors tend to decrease it. This discrepancy is attributable to an increased weight of secondary sectors' final demand on total output and to a decreased weight of tertiary sectors' final demand, which have more than compensated the decrease in multipliers for secondary sectors and the increase in multipliers for tertiary sectors, respectively.

In 2000, the sectors which represented in 1992 key sectors in terms of I-O elasticities for policy makers remain about the same.

Results of the output decomposition analysis are shown in Tabs. 3, 4, 5 and 6. There emerges that in the period 1992-2000, output at constant prices has increased by 22%, which corresponds to an average annual growth rate of about 2.8% (Tab. 3).

Most sectors have increased their contribution to national output. The biggest increases in absolute terms have regarded particularly business services, credit and insurance, transportation and communications, electrical and optical equipment and trade. In relative terms, the sectors, which have registered bigger expansion, are fishing, credit and insurance, electrical and optical equipment and machinery. Instead, the few sectors,

which have experienced a contained decrease in output, are: real estate and rental, construction and education.

Tab. 3 – The components of change in output in Italy, 1992-2000 (€ million, 2000 prices)

Sectors	Technology effect	%	Final demand effect	%	Total	Var. % 92-00
Agriculture, forestry, hunting	2,831	140	-814	-40	2,017	5
Fishing	814	50	800	50	1,614	86
Mining	3,460	52	3,157	48	6,617	43
Food and Tobacco	2,912	184	-1,330	-84	1,582	2
Textile products and apparel	-5,616	-45	18,077	145	12,461	21
Leather and shoes	-2,145	-44	7,022	144	4,877	26
Timber and furniture	706	12	5,059	88	5,765	45
Paper, printing, publishing	2,977	24	9,485	76	12,461	39
Chemicals	-16,370	-618	19,019	718	2,649	3
Rubber and plastic products	-1,046	-15	8,222	115	7,176	37
Products of non-metal minerals	1,057	16	5,594	84	6,651	24
Metal products	-2,098	-7	31,892	107	29,794	41
Machinery	-5,476	-19	34,358	119	28,881	52
Electrical and optical equipment	4,009	11	30,871	89	34,880	54
Means of transportation	-2,682	-25	13,315	125	10,633	21
Other manufacturing	-1,682	-15	12,779	115	11,097	43
Electricity, gas and water	3,987	61	2,539	39	6,526	18
Construction	-3,608	57	-2,742	43	-6,350	-6
Trade	2,786	8	31,747	92	34,533	20
Hotels and businesses	-619	-10	7,124	110	6,505	14
Transportation and communications	4,462	12	33,355	88	37,817	38
Credit and insurance	27,643	66	14,307	34	41,950	55
Real estate and rental	-12,490	226	6,953	-126	-5,537	-7
Business services	22,570	49	23,324	51	45,894	49
Public administration	-40	-2	1,928	102	1,888	3
Education	0	0	-1,215	100	-1,215	-3
Health	93	3	3,120	97	3,213	5
Other services	2,315	27	6,410	73	8,725	17
TOTAL	28,750	8	324,355	92	353,105	22

Source: Author's elaboration

The increase in output can be mainly attributed to final demand effect, which explains 92% of the variation. The technological effect is only responsible for 8%. The structure of the Italian economy has been thus involved by bigger changes in final demand rather than technology changes.

With regard to the output change due to technological effect, more than a half of sectors show positive variations. The sectors registering the highest change in output caused by technology effect are credit and insurance and business services. Among the sectors with negative

variation, those showing the highest negative values are chemicals and real estate and rental.

The output change due to final demand effect results to be in absolute terms bigger than the technological one for almost all sectors. Exceptions are represented by agriculture, food and tobacco, credit and insurance and real estate and rental, for which technological effect has had a predominant role in generating output variation.

The final demand effect results to be for almost all sectors positive and reaches the highest values for the following sectors: machinery, transportation and communications, metal products, trade and electrical and optical equipment. Instead, it is negative in the cases of construction, food and tobacco and education.

Tab. 4 allows deepening the analysis, by investigating on the technological causes, which underlie output change.

A first consideration is that productivity and substitution effects are not able alone to explain technological change, as the remarkable value of output change correlated to specific and non-observed causes demonstrates. Substitution effect explains a decrease by 14% whereas the productivity effect explains only a rise by 34%. An increase by 79% is attributable to specific sector effects.

The substitution effect indicates that there has been on average a reduction of the quantity of inputs by 4,000 € million sold to sectors whereas the productivity effect indicates that sectors have increased on average the use of intermediate inputs by 10,000 € million. The net effect deriving from the joint action of both effects has been clearly positive.

Analysing the single sectors, it emerges that for most sectors, change in output is, in absolute terms, mainly due to substitution effects rather than productivity effects.

Tab. 4 – The technological components of change in output in Italy, 1992-2000 (€ million, 2000 prices)

Sectors	Technological effect						
	Substitution	%	Productivity	%	Specific	%	Total
Agriculture, forestry, hunting	1,590	56	-5,794	-205	7,035	249	2,831
Fishing	774	95	-3	0	43	5	814
Mining	-1,193	-34	999	29	3,654	106	3,460
Food and Tobacco	344	12	-3,212	-110	5,780	198	2,912
Textile products and apparel	-11,174	199	4,416	-79	1,142	-20	-5,616
Leather and shoes	-2,539	118	391	-18	3	0	-2,145
Timber and furniture	1,052	149	738	105	-1,084	-154	706
Paper, printing, publishing	2,240	75	1,727	58	-990	-33	2,977
Chemicals	-22,993	140	1,382	-8	5,240	-32	-16,370
Rubber and plastic products	-1,728	165	919	-88	-237	23	-1,046
Products of non-metal minerals	1,247	118	-5,156	-488	4,966	470	1,057
Metal products	-2,627	125	6,020	-287	-5,491	262	-2,098
Machinery	-6,794	124	2,547	-47	-1,230	22	-5,476
Electrical and optical equipment	7,054	176	-690	-17	-2,355	-59	4,009
Means of transportation	-3,663	137	580	-22	401	-15	-2,682
Other manufacturing	-1,774	105	427	-25	-336	20	-1,682
Electricity, gas and water	1,122	28	1,278	32	1,587	40	3,987
Construction	-3,853	107	-4,382	121	4,628	-128	-3,608
Trade	370	13	-478	-17	2,894	104	2,786
Hotels and businesses	-884	143	448	-72	-183	30	-619
Transportation and communications	4,008	90	1,293	29	-839	-19	4,462
Credit and insurance	30,055	109	1,604	6	-4,015	-15	27,643
Real estate and rental	-13,404	107	1,095	-9	-181	1	-12,490
Business services	19,319	86	4,774	21	-1,523	-7	22,570
Public administration	-46	115	6	-16	0	1	-40
Education	0	0	0	0	0	0	0
Health	-490	-527	-2,050	-2,206	2,633	2833	93
Other services	37	2	1,009	44	1,268	55	2,315
TOTAL	-3,949	-14	9,889	34	22,810	79	28,750

Source: Author's elaboration

With reference to substitution process, results indicate that there has been a considerable increase on average in the use of intermediate inputs produced by credit and insurance, business services and electrical and optical equipment sectors in front of a decrease in inputs coming from chemicals, real estate and rental, textile and machinery sectors.

As for productivity effects, an evident average increase in the use of intermediate inputs can be noticed in metal products, business services and textile. On the contrary, a substantial decrease is registered, in particular, by agriculture, products of non-metal minerals and construction.

The specific effect tends to be in absolute terms higher than the other effects in almost all sectors. Only for some sectors, productivity and substitution effects are sufficient to explain technology change. These are leather and shoes, rubber and plastic products, hotels and businesses, real estate and rental and public administration.

With reference to output change due to final demand effect, this latter has been positive for most sectors with the exceptions of agriculture, food and tobacco, construction and education (Tab. 5).

Tab. 5 – The final demand components of change in output in Italy, 1992-2000 (€ million, 2000 prices)

Sectors	Final demand effect						
	Level	%	Product Mix	%	Category	%	Total
Agriculture, forestry, hunting	7,227	-888	-6,934	852	-1,106	136	-814
Fishing	446	56	459	57	-106	-13	800
Mining	3,147	100	-656	-21	665	21	3,157
Food and Tobacco	15,302	-1151	-13,469	1013	-3,163	238	-1,330
Textile products and apparel	11,337	63	1,144	6	5,595	31	18,077
Leather and shoes	3,574	51	904	13	2,544	36	7,022
Timber and furniture	2,664	53	1,471	29	925	18	5,059
Paper, printing, publishing	6,408	68	2,373	25	704	7	9,485
Chemicals	16,902	89	-2,145	-11	4,262	22	19,019
Rubber and plastic products	3,895	47	1,845	22	2,483	30	8,222
Products of non-metal minerals	5,318	95	-1,358	-24	1,633	29	5,594
Metal products	14,933	47	7,601	24	9,357	29	31,892
Machinery	11,758	34	12,321	36	10,278	30	34,358
Electrical and optical equipment	13,846	45	11,081	36	5,944	19	30,871
Means of transportation	9,629	72	-238	-2	3,924	29	13,315
Other manufacturing	5,332	42	4,546	36	2,901	23	12,779
Electricity, gas and water	6,766	266	-3,221	-127	-1,006	-40	2,539
Construction	18,072	-659	-15,889	579	-4,925	180	-2,742
Trade	32,087	101	5,665	18	-6,005	-19	31,747
Hotels and businesses	8,387	118	2,599	36	-3,861	-54	7,124
Transportation and communications	19,875	60	10,237	31	3,243	10	33,355
Credit and insurance	16,470	115	-4,646	-32	2,484	17	14,307
Real estate and rental	14,101	203	-1,556	-22	-5,592	-80	6,953
Business services	19,845	85	2,672	11	808	3	23,324
Public administration	10,832	562	-3,005	-156	-5,900	-306	1,928
Education	7,831	-645	-4,814	396	-4,232	348	-1,215
Health	12,513	401	-2,642	-85	-6,750	-216	3,120
Other services	9,605	150	393	6	-3,587	-56	6,410
TOTAL	308,101	95	4,735	1	11,519	4	324,355

Source: Author's elaboration

The biggest increases have been registered by machinery, transportation and communications, metal products, trade and electrical and optical equipment.

Most variation is attributable to final demand level (95% of output variation). The redistribution of final demand among category and products only explain 4% and 1% of output variation, respectively. This means that the structure of final demand has remained at an overall level quite unaltered.

Examining single sectors, the level component for most sectors overcomes in absolute terms the other final demand components. The exceptions are given by fishing and machinery of which a big part of the change in output is due to a modification of product mix. All sectors, in particular trade, show an increase in the level of final demand.

Results related to the product mix effect indicate that there has been a big shift of final demand from construction and food and tobacco to machinery, electrical and optical equipment and transportation and communications whereas results related to the category effect show that the biggest shifts among final demand categories have interested, in particular, machinery and metal products.

Analysing in more detail the components of final demand, it emerges that the increase in the level of final demand is for 62% attributable to a rise in consumption (Tab. 6). The remaining part of 38% can be ascribed equally to exports and investments. Also at a level of single sectors, consumption is the main component which explains the increase in the level of final demand. The sectors which make exception are rubber and plastic products, metal products and machinery where the share of exports overcomes the other components and products of non-metal minerals, electrical and optical equipment and construction where investments are the predominant component.

Tab. 6 – The level final demand component of change in output in Italy per category, 1992-2000

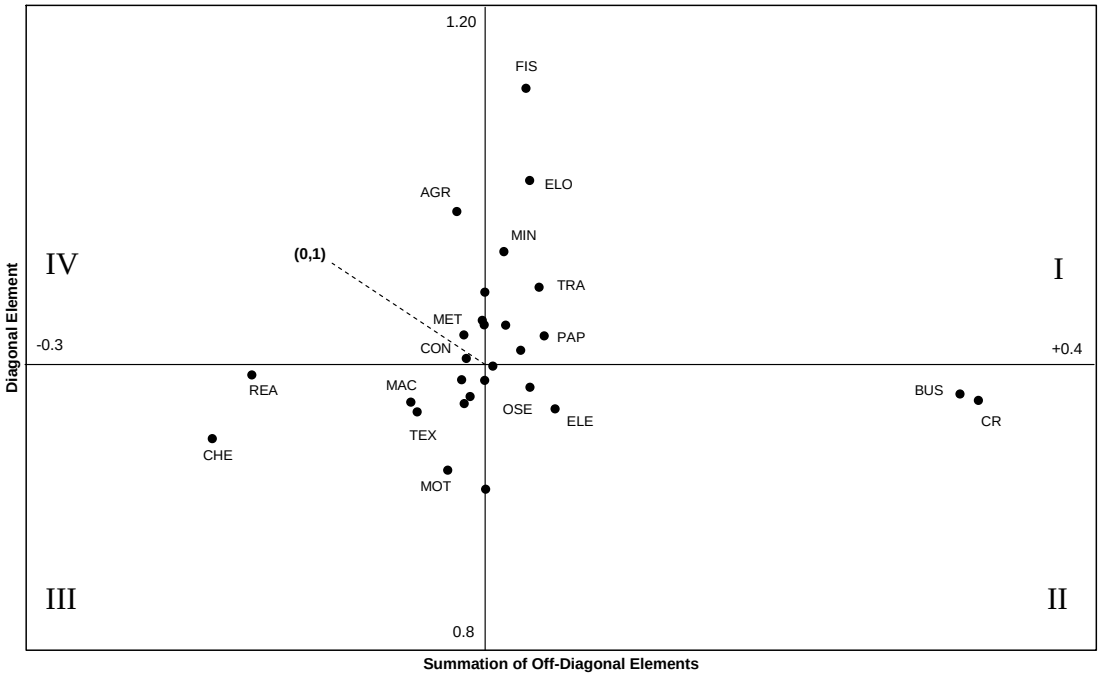
Sectors	Consumption (%)	Investments (%)	Inventory change (%)	Exports (%)	Total (€ million, 2000 prices)
Agriculture, forestry, hunting	84.3	0.9	1.0	13.7	7,227
Fishing	84.2	4.1	0.1	11.6	446
Mining	57.2	15.3	1.6	25.9	3,147
Food and Tobacco	86.6	0.7	0.6	12.1	15,302
Textile products and apparel	59.3	1.6	0.4	38.7	11,337
Leather and shoes	51.7	1.1	-0.8	48.0	3,574
Timber and furniture	40.7	27.5	1.5	30.3	2,664
Paper, printing, publishing	66.3	9.8	-0.3	24.2	6,408
Chemicals	62.3	8.5	-0.4	29.6	16,902
Rubber and plastic products	39.7	17.1	-0.1	43.3	3,895
Products of non-metal minerals	25.5	46.6	0.3	27.6	5,318
Metal products	22.0	36.9	0.4	40.6	14,933
Machinery	12.6	36.9	0.1	50.4	11,758
Electrical and optical equipment	25.1	41.7	0.6	32.6	13,846
Means of transportation	37.0	29.3	2.2	31.5	9,629
Other manufacturing	41.9	17.9	1.5	38.7	5,332
Electricity, gas and water	76.1	9.9	0.2	13.8	6,766
Construction	13.0	84.7	0.0	2.4	18,072
Trade	77.4	9.9	0.4	12.3	32,087
Hotels and businesses	94.0	3.0	0.0	3.0	8,387
Transportation and communications	61.7	12.6	0.1	25.5	19,875
Credit and insurance	68.8	5.8	0.1	25.3	16,470
Real estate and rental	88.6	6.3	0.1	5.0	14,101
Business services	59.6	20.1	0.2	20.1	19,845
Public administration	100.0	0.0	0.0	0.0	10,832
Education	99.9	0.0	0.0	0.1	7,831
Health	99.7	0.1	0.0	0.2	12,513
Other services	88.7	5.2	0.1	6.0	9,605
TOTAL	61.9	17.7	0.3	20.1	308,101

Source: Author's elaboration

Fig. 1 reports graphical results of the application of causative matrix method. The graph has been subdivided into 4 quadrants according to the values taken by diagonal elements and the sums of off-diagonal elements. The quadrants which offer more interesting information are quadrants I and III.

The quadrant I includes the sectors with positive deviations of diagonal elements from 1 and positive deviations of summation of off-diagonal elements from zero. Here we find, in particular, fishing, electrical and optical equipment, mining, transportation and communications, paper and printing. These sectors have increased their contribution to output impacts engendered by both their own final demand and final demand of all the other sectors.

Fig. 1 – Graphical typology of Italy sector-specific I-O structural change, based on the left causative matrix method, 1992-2000



Legend: AGR – Agriculture, forestry, hunting; FIS – Fishing; MIN – Mining; TEX – Textile products and apparel; PAP – Paper, printing, publishing; CHE – Chemicals; MET – Metal products; MAC – Machinery; ELO – Electrical and optical equipment; ELE – Electricity, gas and water; MOT – Means of transportation; CON – Construction; TRA – Transportation and communications; CRE – Credit and insurance; REA – Real estate and rental; BUS – Business and services; OSE – Other services.

Source: Author's elaboration

The quadrant III includes the sectors exhibiting negative deviations of diagonal elements from 1 and negative deviations of summation of off-diagonal elements from zero. In this part of the graph, there appear in particular chemicals, real estate and rental, textile, machinery, means of transportation. The presence of these latter in this portion of the graph would indicate that these sectors have reduced their contribution to output impacts engendered by both their own final demand and final demand of all the other sectors.

Different from the previous two, the quadrants II and IV refer to sectors having deviations of different signs. More specifically, the quadrant II includes the sectors which have reduced their contribution due to their own final demand but, at the same time, have increased their contribution caused by final demand of other sectors. In particular, there

can be found other services, electricity, gas and water, credit and insurance and business services. Finally, quadrant IV includes the sectors which have increased their contribution due to their own final demand but have reduced that induced by final demand of other sectors. Here we find, in particular, agriculture, metal products and construction.

In general, looking at the figure, it can be noted that most sectors tend to concentrate around the point (0,1). This would attest that the variation of contribution of sectors to output impacts has been generally contained in the nineties for many sectors.

4 Concluding remarks

In this paper, an analysis of structural changes in Italy for the period 1992-2000 was carried out. The tool used was an I-O framework by means of multipliers, elasticities, structural decomposition and causative approaches.

The main results can be summarised as follows. From the analysis of multipliers, it results that, in terms of output, other manufacturing (i.e. furniture, musical instruments, jewellery) and machinery represent for Italy important sectors able to stimulate production thanks to their high levels of sector interdependence. During the nineties, agro-food sector has strengthened its linkages whereas other sectors, such as textile and leather and shoes, which are considered strategic for the Italian economy, have weakened.

With reference to employment, agriculture confirms to be still an important sector for Italy for its higher employment multiplier, only being preceded by other services and education. In any case, during the nineties, as the decreases in employment multipliers reveal, Italy has been interested by a generalized increase in labour productivity, especially in agriculture, textile and leather and shoes.

In terms of value added, tertiary sectors are those which activate higher levels of richness per one additive unit of final demand. During the nineties, their role has strengthened differently from primary and secondary sectors which have reduced their capacity of producing value added. In contrast to the general tendency, the agro-food sector increases its value added multiplier and this result confirms the general reinforcement of the backward linkages of the agro-food sector even in terms of value added.

Analysing also the weight of each sector in the economy, conclusions are substantially different from those deriving from the examination of multipliers. In fact, it emerges that trade and construction are those having the highest potential to generate output, employment and value added. Therefore, if policy makers intended realistically to affect the macro-variables examined, they should aim to these sectors and not to those exhibiting only high levels of sector linkages. Moreover, although potentiality expressed by tertiary sectors has always been greater, during the nineties it decreased whereas that of secondary sectors, in particular machinery, has increased.

From 1992 to 2000, results of the SDA analysis show that the Italian output has increased by 22% (corresponding to an average annual growth rate of about 2.8%), thanks to the expansion which has interested mainly the sectors of business services, credit and insurance, transportation and communications, electrical and optical equipment and trade. Most output variation (92%) is attributable to the growth of the level of final demand and in particular of consumption. Only 8% is due to technological causes. About these latter, the effect related to the intensity in the use of intermediate inputs (productivity effect) and that related to substitution of intermediate inputs (substitution effect) explain an increase in output by 34% and a decrease in production by 14%, respectively. The increase by 79% is instead due to other specific sector effects. With regard to the substitution effect, there emerges a tendency of industries to substitute

inputs related to chemicals, real estate and rental, textile and machinery with inputs related to credit and insurance, business services and electrical and optical equipment.

Further information comes from the application of the causative approach. Results indicate that the variation of sector contribution to output impacts has been contained in the nineties. At a sector level, there emerges that sectors such as fishing, mining, paper and printing, transportation and communications and electrical and optical equipment have increased their contribution to output impacts generated by their final demand and the final demand of other sectors, whereas others such as agriculture, metal products and construction have reduced their capability of contributing to output impacts induced by both their final demand and that of other sectors.

Definitively, during the nineties, process of development has led to reinforcement of sectors more related to service supply and to an increasing reduction of the importance of agriculture and manufacturing sectors. Moreover, Italy has been interested by structural changes mainly due to the variation of the level of final demand, in particular of consumption, rather than technological changes. Finally, Italy, in line with the general tendency of other industrialised countries, has been involved by the process of rising diffusion and importance of computer and communication technologies throughout the whole economy.

References

Andreosso-O'Callaghan, B. and Yue, G. (2002), Sources of Output Change in China: 1987-1997: Application of a Structural Decomposition Analysis, *Applied Economics* 34: 2227-37.

Bacharach M. (1970), *Biproportional Matrices and Input-Output Change*, Cambridge University Press, London.

Chenery, H. (1979), *Structural Change and Development Policy*, Oxford University Press.

Ciobanu, C., Mattas, K. and Psaltopoulos, D. (2004), Structural Changes in Less Developed Areas: An Input-Output Framework, *Regional Studies* 38: 603-14.

Dietzenbacher, E. and Los, B. (1998) Structural decomposition techniques: sense and sensitivity, *Economic Systems Research* 10: 307-323.

Eurostat (1996), *European System of Accounts 1995 – ESA95*, CECA-CE-CEEA, Luxemburg.

Guerrieri, P. and Rossi, S. (2000), Vantaggi competitivi reali nell'Europa con un solo mercato e una sola moneta, in Padoan, P. C. (eds), *L'Euro e i Mercati Reali*, Bologna: Il Mulino.

Hoekstra, R. and van den Bergh, J. C. J. M. (2002), Structural Decomposition Analysis of Physical Flows in the Economy, *Environmental and Resource Economics* 23: 357-78.

ISTAT (2000), *Tavola intersettoriale dell'economia italiana – Anno 1992*, Collana Informazioni, Rome.

Jackson, R. W., Rogerson, P., Plane D. and O'hUallachain, B (1990), A Causative Matrix Approach to Interpreting Structural Change, *Economic Systems Research* 2: 259-69.

Kagawa, S. and Inamura, H. (2001), A Structural Decomposition of Energy Consumption Based on a Hybrid Rectangular Input-Output Framework: Japan's Case, *Economic Systems Research* 13: 339-63.

Kagawa, S. and Inamura, H. (2004), A Spatial Structural Decomposition Analysis of Chinese and Japanese Energy Demand: 1985-1990, *Economic Systems Research* 16: 279-99.

van der Linden, J.A. and Dietzenbacher, E. (2000), The determinants of structural change in the European Union: a new application of RAS, *Environment and Planning A* 32: 2205-2229.

van der Linden, J.A. and Hoekstra R. (2002), The RAS structural decomposition approach, in Hewings, G.J.D., Sonis M. and Boyce D. (eds.), *Trade, Networks and Hierarchies*, Springer, Heidelberg, pp. 179-199.

Lecomber, J. R. C. (1975), A Critique of Methods of Adjusting, Updating and Projecting Matrices, in Allen R. I. G. and Gossling W. F. (eds), *Estimating and Projecting Input-Output Coefficients*, Input-Output Publishing Company, London, pp. 1-25.

Liu, A. and Saal D. (2001), Structural Change in Apartheid-Era South Africa: 1975-93, *Economic Systems Research* 13: 235-57.

Mantegazza, S. and Mastrantonio, L. (2003), La matrice input-output nazionale: stato di fatto e prospettive, Report presented at the Seminar "L'approccio input-output per il ciclo programmazione – monitoraggio – valutazione", Rome, December 18, 2003.

Mantegazza S., Mastrantonio L. and Salerno P. (2004), *Il nuovo sistema input-output*, Rome: ISTAT.

Mattas, K. and Shrestha, C. M. (1991), A new approach to determine sectoral priorities in an economy: input-output elasticities, *Applied Economics* 23, 247-254.

Miller, R. E. and Blair, P. D. (1985), *Input-Output Analysis: foundations and extensions*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Mukhopadhyay, K. and Chakraborty, D. (2004), Energy Consumption Changes and CO2 Emission in India during Reforms, *Journal of Quantitative Economics* 2: 76-97.

de Nardis, S. (1997), Persistenza e cambiamento delle specializzazioni manufatturiere: l'industria italiana nel confronto con i principali paesi, *Rivista di Politica Economica* 137.

Onida, F. (1978), *Industria italiana e commercio internazionale*, Bologna: Il Mulino.

Roy, S., Das, T. and Chakraborty, D. (2002), A Study on the Indian Information Sector: An Experiment with Input-Output Techniques, *Economic Systems Research* 14: 107-29.

Stone, R. (1961), *Input-Output and National Accounts*, Paris: Organization for European Economic Cooperation.

Stone, R. and Brown, J. A. C. (1962), A Long-term Growth Model for the British Economy, in Geary J. A. C. (eds.), *Europe's Future in Figures*, Amsterdam: North-Holland.