Structural change and productive blocks in the Spanish Economy: An input-output analysis for 1980-1994.

Julio Sánchez Chóliz and Rosa Duarte

Abstract:

The objective of this paper is to analyse structural and technological change in the Spanish economy between 1980 and 1994 using the Input-Output tables of 1980, 1986, 1990 and 1994. Firstly we obtain and compare four linkage components throughout the period for each of the 9 sectorial blocks in which the economic sectors are grouped. Secondly, using Structural Decomposition Analysis, we obtain a technological effect and a demand effect for each of the previous components. These pressures show the process of the technological modernisation of the Spanish economy, strongly linked to the growth of the high and medium technology sectors and the service sectors, and the different contribution of these sectors to the improvement of productivity. On the one hand, the technology sectors increase productivity by using better technologies. On the other hand, the service sectors do not raise it significantly and even reduce it by increasing their unit costs.

Key words: Structural Decomposition Analysis, Technical change, Input-output, Spanish economy

JEL classification: C67, D57, O30, O52.

1. Introduction

In recent decades, Spain has undergone an economic growth at a rate that has permitted a real convergence with the other countries of the European Union. The aggregate data, however, do not permit us to fully understand how this growth has come about with respect to what have been the determining factors of the evolution of the Spanish economy from the point of view of production, in which sectors this evolution has been based, and whether this growth has been reflected in a real change of production techniques. The principal objective of this paper is to study the changes that have occurred in Spanish economic activity in the period 1980-1994, paying special attention to the role that the sectorial blocks with different technological levels have played. In addition, we are interested in determining whether there has been a true process of technological change in the Spanish economy or whether, on the contrary, growth has been based on a re-dimensioning of the traditional sectors to satisfy larger volumes of final demand. The analysis of how the Spanish economy has changed during this period will, without doubt, serve to evaluate the present situation and to suggest future growth and development paths in Spain.

The multi-sectorial framework allows us to dig deeply into these questions. From the methodological point of view, our starting point will be the instruments of input-output analysis, the concept of vertical integration (Pasinetti 1973, 1975, 1977)[i], Structural Decomposition Analysis (SDA) and Generalised linkage indicators (Sánchez Chóliz and Duarte, 2003). These generalised indicators are close to some developments of the Hypothetical Extraction Method (Cella, 1984; Guccione, 1986; Miller and Lahr, 2001), they reduce the aggregation requirements, they are

appropriate for analysis by sectorial blocks and they allow us to define the linkage indicators associated with the **B** matrix in terms of matrix **A**.

The vertical integration also allows us to capture all the productive linkages, thus favouring the analysis of the structural changes. Within the framework of a demand-driven input-output model, it allows us to decompose the production flows between sectorial blocks into four linkage components: net backward component, net forward component, internal component and mixed component, showing us the role that each block plays as a demander of inputs from the other blocks and as a supplier of inputs or as a driver of its own activities.

With the aim of analysing the evolution of the Spanish economy, we study the changes in the four previous components of each block using instruments derived from Structural Decomposition Analysis (SDA). The breakdown of the production flows into four components allows us to amplify the information traditionally obtained with SDA by applying the decomposition to each of them. SDA thus gives us four technological effects and four demand effects per block, which allows us to see the underlying sectorial linkages in the structural changes better. Three of the technological effects tell us about the technological change associated with the activities of the block, the fourth about the technological change in other blocks[ii]. Moreover, two of the demand effects are associated with the demand for inputs produced and consumed by the block and the other two with inputs purchased from and sold to other blocks. In our opinion, this way of applying SDA is new and we believe that it has never been applied to the Spanish economy.

The results suggest that from 1980 to 1994, there has been a two-fold process in the Spanish economy. On the one hand, a strong process of technological change that has mainly affected the high and medium technology sectors and the construction

sector. On the other hand there has been an increase in the activities of services which **is** based on low technologies or on the purchase of technology. These processes have opposite influences on productivity and have decisively marked the evolution of recent years. Another fact that has been observed, and was expected, is that most of the growth in production can be explained by the demand effects, which, due to their larger size, tend to overshadow the effects of the technological transformations.

The rest of the work is organised in the following way. In Section 2 we develop the methodological aspects, focussing especially on how the SDA is applied to an economy described by sectorial blocks and flow components between blocks. In Section 3 we carry out the empirical application for the Spanish economy. In the first subsection, we present the data base used in order to apply the instruments described in Section 2. In the second, the principal directions of structural change are analysed with the help of the linkage components. In the third subsection, we obtain the technological and demand effects of the SDA, which allow us to better explain the technological transformations that have occurred. The main results are presented throughout these last two subsections.

2. Methodology.

A demand-driven input-output model of an economy made-up of n sectors can be described by the quantity equation $\mathbf{x} = \mathbf{A}\ \mathbf{x} + \mathbf{y}$, where $\mathbf{x} = (x_i)$ denotes the output vector, $x = \Sigma x_i$ the total output, $\mathbf{A} = (a_{ij})$ the input coefficients matrix, $\mathbf{y} = (y_i)$ the vector of final demands and $y = \Sigma y_i$ the total final demand. The output in this economy can also be written as $\mathbf{x} = \mathbf{(I-A)^{-1}\ y}$, where $\mathbf{(I-A)^{-1}}$ is the Leontief inverse. We use $\mathbf{u'}$ to denote an $1 \times n$ vector of ones. Furthermore, if G_s represents a block of

sectors of the economy and G_{-s} the remaining sectors, the earlier output equations can be represented in the following way:

$$\begin{bmatrix} \mathbf{x}_s \\ \mathbf{x}_{-s} \end{bmatrix} = \begin{bmatrix} \mathbf{A}_{s,s} & \mathbf{A}_{s,-s} \\ \mathbf{A}_{-s,s} & \mathbf{A}_{-s,-s} \end{bmatrix} \begin{bmatrix} \mathbf{x}_s \\ \mathbf{x}_{-s} \end{bmatrix} + \begin{bmatrix} \mathbf{y}_s \\ \mathbf{y}_{-s} \end{bmatrix}$$
$$\begin{bmatrix} \mathbf{x}_s \\ \mathbf{x}_{-s} \end{bmatrix} = \begin{bmatrix} \mathbf{D}_{s,s} & \mathbf{D}_{s,-s} \\ \mathbf{D}_{-s,s} & \mathbf{D}_{-s,-s} \end{bmatrix} \begin{bmatrix} \mathbf{y}_s \\ \mathbf{y}_{-s} \end{bmatrix}, \text{ with } \mathbf{D} = (\mathbf{I} - \mathbf{A})^{-1} = \begin{bmatrix} \mathbf{D}_{s,s} & \mathbf{D}_{s,-s} \\ \mathbf{D}_{-s,s} & \mathbf{D}_{-s,-s} \end{bmatrix} \quad (1)$$

From these relationships, the activity of each block G_s in this demand-driven model can be decomposed into four separate linkage components:

Internal component: $(\mathbf{I} - \mathbf{A}_{s,s})^{-1}\mathbf{y}_s$

Mixed component: $\left[\mathbf{D}_{s,s} - (\mathbf{I} - \mathbf{A}_{s,s})^{-1}\right]\mathbf{y}_s$ (2)

Net backward component: $\mathbf{D}_{-s,s}\mathbf{y}_s$

Net forward component: $\mathbf{D}_{s,-s}\mathbf{y}_{-s}$

With which we can associate four separate scalar linkage indicators, namely:[iii]

Internal indicator: $I_s = \mathbf{u}_s'(\mathbf{I} - \mathbf{A}_{s,s})^{-1}\mathbf{y}_s$

Mixed indicator: $M_s = \mathbf{u}_s'\left[\mathbf{D}_{s,s} - (\mathbf{I} - \mathbf{A}_{s,s})^{-1}\right]\mathbf{y}_s$ (3)

Net backward indicator: $B_s = \mathbf{u}_{-s}'\mathbf{D}_{-s,s}\mathbf{y}_s$

Net forward indicator: $F_s = \mathbf{u}_s'\mathbf{D}_{s,-s}\mathbf{y}_{-s}$

The interpretation of these components and indicators is very clear. As is well known, we can describe production as a chain of processes that, beginning with some initial inputs, produce intermediate inputs, that are, in turn, used as inputs in the following process, until the final demand is obtained. This chain is the basis of what we call vertically integrated production. According to this view of the productive process, the internal component $(\mathbf{I} - \mathbf{A}_{s,s})^{-1}\mathbf{y}_s$ consists of the inputs produced by the sectors of G_s, with no intervention from other blocks, and used by G_s to obtain its final

demand $\mathbf{y_s}$. The mixed component $\left[\mathbf{D}_{s,s} - (\mathbf{I} - \mathbf{A}_{s,s})^{-1}\right]\mathbf{y}_s$ consists of the inputs produced by G_s, with the intervention of other blocks in some of the intermediate stages, and that are consumed by G_s to obtain $\mathbf{y_s}$. The word "mixed" refers to this collaboration in the production. The net backward component $\mathbf{D}_{-s,s}\mathbf{y}_s$ are the inputs produced by other sectors and used in G_s to produce $\mathbf{y_s}$. And finally, the net forward component $\mathbf{D}_{s,-s}\mathbf{y}_{-s}$ are the inputs produced in G_s and consumed to produce the final demand of other blocks. These last two components are net components because they do not include the self-consumption.

If we recall that in the demand-driven input-output model all goods are valued at price 1, from (2) and (3) we can see that the linkage indicators are the value of the different components at these prices. Thus, the I_s measures the cost of the inputs that are produced exclusively within block G_s with no intervention from other blocks, with the aim of producing the final demand of the block. The M_s measures the difference between the self-consumption of inputs and the I_s. Similarly, B_s measures the value of the purchases of inputs that G_s does not produce and that it obtains from the other blocks to produce its final demand $\mathbf{y_s}$. Finally, F_s measures the value of the sales of inputs generated in G_s from this block to all the other blocks of the economy so that they can meet their final demands. Furthermore, based on (3), we can see that $I_s+M_s+B_s$ is the value V_s of the vertically integrated production of block G_s. Similarly, $I_s+M_s+F_s$ is the total output x_s of block G_s.

An approach frequently used to analyse the changes produced in an economy through time is the so-called Structural Decomposition Analysis (SDA) which has its origins in the developments of Carter (1970) and that has produced an important body of literature (see, for example, Blair and Wyckoff (1989) or Skolka (1989), among others, or Rose and Casler (1996), for a critical review of the technique). SDA allows

the decomposition of input-output relations between any two temporal moments, 0 and 1, as a sum of effects associated with each of the individual sources of change. For example, if $\mathbf{x} = \mathbf{(I-A)^{-1}y} = \mathbf{Dy}$, $\Delta\mathbf{x} = \mathbf{x}(1)-\mathbf{x}(0)$, $\Delta\mathbf{D} = \mathbf{D}(1)-\mathbf{D}(0)$ and $\Delta\mathbf{y} = \mathbf{y}(1)-\mathbf{y}(0)$, the change in production will be: $\Delta\mathbf{x} = \Delta\mathbf{D}\ \mathbf{y} + \mathbf{D}\ \Delta\mathbf{y} + \Delta\mathbf{D}\ \Delta\mathbf{y}$. The first addend is the technological effect (vertically integrated) and measures the changes in the input coefficients under conditions of fixed final demand. The second is the demand effect (vertically integrated) and gathers the direct and indirect effects due to the changes in the final demand under conditions of fixed technology. Lastly, the third is a residual term that measures the change that cannot be assigned uniquely either to the technical change or to the change in the final demand.

The use of decomposition into blocks and the definition of their linkage components is also compatible with the use of the SDA. In this case, with the SDA we can see, for any change in production, which part is due to technical changes in the blocks and which part is due to changes in the final demands of the blocks. More than that, it is possible to measure which part of these effects is linked to purchases from other blocks, sales to others or to the internal production activity of the block itself.

Let's take a closer look. From (1), the variations in the productions of each block can be expressed in the following way:

$$\begin{bmatrix} \Delta\mathbf{x}_s \\ \Delta\mathbf{x}_{-s} \end{bmatrix} = \begin{bmatrix} \Delta\mathbf{D}_{s,s} & \Delta\mathbf{D}_{s,-s} \\ \Delta\mathbf{D}_{-s,s} & \Delta\mathbf{D}_{-s,-s} \end{bmatrix} \begin{bmatrix} \mathbf{y}_s \\ \mathbf{y}_{-s} \end{bmatrix} + \begin{bmatrix} \mathbf{D}_{s,s} & \mathbf{D}_{s,-s} \\ \mathbf{D}_{-s,s} & \mathbf{D}_{-s,-s} \end{bmatrix} \begin{bmatrix} \Delta\mathbf{y}_s \\ \Delta\mathbf{y}_{-s} \end{bmatrix} + \begin{bmatrix} \Delta\mathbf{D}_{s,s} & \Delta\mathbf{D}_{s,-s} \\ \Delta\mathbf{D}_{-s,s} & \Delta\mathbf{D}_{-s,-s} \end{bmatrix} \begin{bmatrix} \Delta\mathbf{y}_s \\ \Delta\mathbf{y}_{-s} \end{bmatrix} \tag{4}$$

From which it is deduced, if $\mathbf{x_s}$ is the production of G_s and $\mathbf{V_s}$ its vertically integrated production, that

$$\Delta \mathbf{x_s} = \Delta \mathbf{D_{s,s}}\, \mathbf{y_s} + \mathbf{D_{s,s}}\, \Delta \mathbf{y_s} + \Delta \mathbf{D_{s,s}}\, \Delta \mathbf{y_s} + \Delta \mathbf{D_{s,-s}}\, \mathbf{y_{-s}} + \mathbf{D_{s,-s}}\, \Delta \mathbf{y_{-s}} + \Delta \mathbf{D_{s,-s}}\, \Delta \mathbf{y_{-s}} \quad (5)$$

$$\Delta \mathbf{V_s} = \begin{bmatrix} \Delta \mathbf{D_{s,s}} \mathbf{y_s} + \mathbf{D_{s,s}} \Delta \mathbf{y_s} + \Delta \mathbf{D_{s,s}} \Delta \mathbf{y_s} \\ \Delta \mathbf{D_{-s,s}} \mathbf{y_s} + \mathbf{D_{-s,s}} \Delta \mathbf{y_s} + \Delta \mathbf{D_{-s,s}} \Delta \mathbf{y_s} \end{bmatrix}$$

Moreover, given that the self-consumption of a block can be decomposed into internal component and mixed component, applying the SDA the variations $\Delta \mathbf{x_s}$ and $\Delta \mathbf{V_s}$ can also be expressed as

$$\Delta \mathbf{x_s} = \Delta (\mathbf{I}-\mathbf{A_{s,s}})^{-1}\, \mathbf{y_s} + (\mathbf{I}-\mathbf{A_{s,s}})^{-1}\, \Delta \mathbf{y_s} + \Delta (\mathbf{I}-\mathbf{A_{s,s}})^{-1}\, \Delta \mathbf{y_s} + \Delta [\mathbf{D_{s,s}}-(\mathbf{I}-\mathbf{A_{s,s}})^{-1}]\ \mathbf{y_s}$$
$$+ [\mathbf{D_{s,s}}-(\mathbf{I}-\mathbf{A_{s,s}})^{-1}]\, \Delta \mathbf{y_s} + \Delta [\mathbf{D_{s,s}}-(\mathbf{I}-\mathbf{A_{s,s}})^{-1}]\, \Delta \mathbf{y_s} + \Delta \mathbf{D_{s,-s}}\, \mathbf{y_{-s}} + \mathbf{D_{s,-s}}\, \Delta \mathbf{y_{-s}} + \Delta \mathbf{D_{s,-s}}\, \Delta \mathbf{y_{-s}} \quad (6)$$

$$\Delta \mathbf{V_s} = \begin{bmatrix} \begin{pmatrix} \Delta (\mathbf{I}-\mathbf{A_{s,s}})^{-1} \mathbf{y_s} + (\mathbf{I}-\mathbf{A_{s,s}})^{-1} \Delta \mathbf{y_s} + \Delta (\mathbf{I}-\mathbf{A_{s,s}})^{-1} \Delta \mathbf{y_s} + \Delta \left[\mathbf{D_{s,s}} - (\mathbf{I}-\mathbf{A_{s,s}})^{-1}\right] \mathbf{y_s} \\ + \left[\mathbf{D_{s,s}} - (\mathbf{I}-\mathbf{A_{s,s}})^{-1}\right] \Delta \mathbf{y_s} + \Delta \left[\mathbf{D_{s,s}} - (\mathbf{I}-\mathbf{A_{s,s}})^{-1}\right] \Delta \mathbf{y_s} \end{pmatrix} \\ \left(\Delta \mathbf{D_{-s,s}} \mathbf{y_s} + \mathbf{D_{-s,s}} \Delta \mathbf{y_s} + \Delta \mathbf{D_{-s,s}} \Delta \mathbf{y_s}\right) \end{bmatrix} \quad (7)$$

According to equation (6), for a block G_s the change in the production $\mathbf{x_s}$ of the block can be seen as the sum of nine addends, the first six coming from the SDA applied within block G_s and the last three from the SDA of the inputs sold to other sectors. Specifically, the first addend is the variation in the internal component of the block due to technical change; the second is the change in the internal component due to the variations in its own final demand; the fourth and fifth addends are the corresponding changes in the mixed component; the seventh is the change in the sales to other blocks due to technical change, that is to say, in the net forward component; the eighth is the change in this forward component due to the variation in the final demand of the other blocks; the third, sixth and ninth addends are those of interaction.

Equation (7) also allows us to see how the changes in demand and technology (vertically integrated) of block G_s change the vertically integrated production of G_s. The first six addends are identical to those of equation (6). The seventh addend of this

equation gives us the change in the net backward component (purchases) through changes in the technology of G_S, the eighth, the changes in the net backward component due to changes in its final demand, and the ninth is a residual term. To sum up, we have eight effects for each block, a technological effect and a demand effect for each of its linkage components.

All these effects are, in general, vectors, which leads us to define scalar measures for each of them. The method to obtain them is that used to calculate the linkage indicators, to value the different goods at price 1 and to add the goods to each effect. Thus we will have the following indicators, which will be those used in the empirical analysis:

Technological effect of I_S: $\mathbf{u_s'\Delta(I-A_{s,s})^{-1}\ y_s}$

Technological effect of M_S: $\mathbf{u_s'\Delta[D_{s,s}-(I-A_{s,s})^{-1}]\ y_s}$

Technological effect of B_S: $\mathbf{u_{-s}'\Delta D_{-s,s}\ y_s}$

Technological effect of F_S: $\mathbf{u_s'\Delta D_{s,-s}\ y_{-s}}$

Demand effect of I_S: $\mathbf{u_s'\ (I-A_{s,s})^{-1}\ \Delta y_s}$

Demand effect of M_S: $\mathbf{u_s'\ [D_{s,s}-(I-A_{s,s})^{-1}]\ \Delta y_s}$

Demand effect of B_S: $\mathbf{u_{-s}'D_{-s,\,s}\ \Delta y_s}$

Demand effect of F_S: $\mathbf{u_s'D_{s,-s}\ \Delta y_{-s}}$

A negative technological effect of I_s tells us that the value of the inputs consumed per unit of final demand and produced exclusively in the block itself has been reduced. A negative technological effect of M_s tells us that the value of the inputs consumed in G_s per unit of final demand and produced with the help of other blocks has fallen. A negative technological effect of B_s informs us that the value of the inputs produced in other blocks and purchased from them per unit of final demand has been reduced. And, finally, a negative technological effect of F_s tells us that there are

reductions in the inputs produced in block G_s and used to produce a unit of final demand in other blocks. We should not forget that the effects of B_s and F_s measure exactly the same phenomenon but from two alternative viewpoints We should also note that the technological changes of I_s, M_s and B_s are changes in block G_s, while the change of F_s takes place in other blocks. Consequently, the sum of the technological effects of I_s, M_s and B_s, or the technological effect of I_s+M_s+B_s, will be an indicator of the total technological effect within the block and will give us the reduction in the value of the inputs per unit of demand of the block.

We cannot finalise these notes on the methodology without making a brief comment on the themes of exact decomposition and the non-uniqueness of the solutions of the SDA. With respect to the former, in the literature there are studies that propose methods for achieving exact decompositions (see Dietzenbacher and Los, 1998). In this work, we have opted to carry out an exact decomposition distributing, in all cases, the residual factor in equal parts between its two associated effects, the technological effect and the demand effect.

Furthermore, for the decompositions of changes between an initial date 0 and a final date 1, we have assumed that the initial was the earlier date. This option is not the only one possible. The resulting decompositions change slightly with the option chosen but, except in very exceptional cases, they all allow us to reach similar conclusions; it is simply necessary to carry out the interpretation of the results keeping in mind the moment of reference chosen.

In any case, we have observed that the qualitative results, the classification of the blocks and the importance of the effects of technical change and demand are not altered if either we ignore the residual term or we take the final period or an equidistant moment as a reference. These results are available upon request.

3. Empirical analysis

3.1. Data

The application of all these developments to the Spanish economy requires two additional decisions of an empirical nature: what period our analysis should cover and how to construct the sectorial blocks of our study. The period studied runs from 1980 to 1994, since homogenous input-output tables for 1980, 1986, 1990 and 1994 are available from the National Institute of Statistics and because the decade of the 80s and early 90s is a key period for the Spanish economy. The year 1980 is close in time to the establishment of democracy in Spain. In addition, in 1986 Spain entered the European Economic Community.

With respect to the sectorial blocks into which the Spanish economy has been divided, we follow the distribution of activities based on technology and knowledge carried out by the OECD (2001). This classification, however, refers only to the manufacturing and service sectors, so it is necessary to complete it. Thus, we group the 56 sectors of the Spanish economy into nine production blocks: 1: Primary Sector; 2: Energy Sector, 3: High technology activities; 4: Medium-high technology activities; 5: Medium-low technology activities; 6: Low technology activities; 7: Construction Sector; 8: High qualification services; 9: Other services. The sectors that compose each block are available upon request. In any case, a rough idea can be obtained from the table below:.

Blocks	Some activities or products of the block
Primary	Agriculture and livestock
Energy	Coal, Crude oil, Natural gas and Electric energy
High Technology	Computers, electrical, electronic and optical goods
Medium- high Technology	Chemical, machinery and automobiles
Medium- low Technology	Cement, metallic products and plastic products.
Low Technology	Dairy products, textiles, paper and recycling
Construction	Construction and civil engineering
High Qualification Services	Communications, Banking, Education y Health
Other services	Commerce, Transport and Public administration

We should remember that the methodology used in the paper does not involve the aggregation of the sectors that compose each block allowing us to observe the relationships that are established between the sectors of a block as well as those existing between different blocks.

Furthermore, with the aim of concentrating solely on the real evolution of the economy, the original tables, at current prices, have been converted into constant 1986 monetary units, using the indexes of sectorial prices that the BBV (1999) provides. The transformation to constant prices is especially relevant for the period analysed because during these decades the Spanish economy experienced very high rates of inflation. Thus, in nominal terms, overall production grew 96.5% from 1980 to 1986, 50.8% from 1986 to 1990 and 27.3% from 1990 to 1994. In real terms, the growth figures were, however, 15.2%, 11.7% and 14.61%, respectively. Lastly, given that our interest resides in the study of internal evolution, we eliminate the imports of goods and services from the final demand.

3.2. Structural change in the production blocks

Table 1 shows the value of the total production of each block x_s, that of its vertically integrated production V_s and the four indicators into which we have divided them, that is, I_s, M_s, B_s and F_s. We use percentages to control the effect of size. The

table allows us to analyse the evolution of the backward or forward character of each block, understanding the backward or forward character of a block as its role as a demander of inputs from the other blocks or as a supplier of inputs to other blocks. This evolution gives us a first snapshot of the structural change of the Spanish economy that is completed with the Structural Decomposition Analysis whose figures are collected in Tables 2 and 3.

The first question we must ask ourselves is how the weight of each block varies in the period 1980-1994. The ratios x_s/x of Table 1 allow us to divide the blocks into three groups. The first, made up of the High Technology, Medium-high Technology, High Qualification Services and Other Services blocks, increases its participation. The growth of the High Qualification Services block is especially intense, increasing from 11.32% in 1980 to 14.58% in 1994, growing constantly throughout the period. The second, in which there are three blocks, Primary, Energy and Medium-low Technology, reduces its weight in the economy, especially the latter, which falls from 16.36% in 1980 to 10.27% in 1994, with intermediate values of 11.39% in 1986 and 10.76% in 1990. We should note that the biggest decrease is from 1980 to 1986. Lastly, the third group is composed of the Low Technology and Construction blocks, which maintain their weight over the 14 years.

Thus, a first look at the Spanish economy in this period shows the existence of an important change in the productive structure. One factor of this change has been the incorporation of high technology to substitute that of a lower level, (which justifies the loss of importance of the Medium-low Technology block). The other factor has been the growth of services which are grouped into the High Qualification Services and Other Services blocks. Furthermore, as can be seen, the Construction sector, to

which has been often attributed a decisive driving role in the economy, has maintained its weight over the period.

Table 1, by means of the ratios V_s/x_s, allows us to split the blocks into two groups. The blocks with a V_s higher than x_s and those in which x_s is higher than V_s. We exclude the Energy block because its V_s is negative. The former, with $V_s>x_s$, pull the economy. That is, they require more inputs from the economic system than they supply in order to produce their final demands. In this group we find, in 1980, the High Technology, Medium-high Technology, Low Technology, Construction and Other Services blocks, with only the Low Technology, Construction and Other Services remaining in this group after 1986. On the contrary, the blocks with $V_s<x_s$ push the economy and produce inputs to be incorporated into other sectors more than those they require of the economy to cover their final demands. In this second group, in the years 1986, 1990 and 1994, we find the Primary, High Technology, Medium-high Technology, Medium-low Technology and High Qualification Services, while in 1980 this group only contained three blocks, Primary, Medium-low Technology and High Qualification Services. That is to say, two such significant blocks as High Technology and Medium-high Technology change their character from backward (demander) to forward (supplier). On the other hand, no block changes in the opposite sense. Similarly, if we compare 1980 with 1994, it can be seen that all the blocks, with the exception of Energy and High Qualification Services, have increased their internal indicator while reducing their net backward indicator; in other words, the blocks buy relatively more within the block and less outside.

All this reveals two important characteristics of the structural change in the Spanish economy: the Spanish economy has indeed undergone an increase in the

participation of the knowledge-based sectors and of the service sectors during this period, but it has not evolved towards a greater integration of the blocks.

The Energy block has a different evolution, its weight in the total production decreases systematically. Its negative V_s is drastically reduced from -147.11 % of its production in 1980 to -19.67 % in 1994; its internal indicator I_s also falls from 62.13% of its V_s to 30.81% and its backward indicator B_s, goes from 35.49% to 68.81%. This tells us that it has much reduced, relatively, its dependence on the exterior and has increased, in compensation, its interior purchases. In other words, it changes its backward character weakening the links with the exterior and increasing its integration with other national blocks.

The other productive block that does not follow the trend towards a greater self-integration is High Qualification Services, which can be partly explained by the type of services it generates. Its I_s is always above 73% of the V_s and it is, throughout the period, the highest of all the blocks. This indicates that its activity within the block is fundamental. Nevertheless, its I_s that is 78.61% of the V_s in 1980, although it increases slightly at first, ends up falling to 73.54% in 1994. At the same time, its B_s starts at 20.06% in 1980, falls slightly and then grows to 24.43% in 1994. It has, therefore, a standard evolution from 1980 to 1986 but, in the final sub-periods it becomes more dependent on the other blocks. As we will see later, this block does not follow the pattern of the other sectors in its technological evolution either.

To close the analysis of the data of Table 1 let us look at some particular characteristics of another two blocks, namely, Primary and Construction. The Primary block has the typical evolution of the economy that we have commented: it is focused more on its own block. However, although from 1980 to 1990 it follows the general pattern, from 1990 to 1994 all the trends are inverted, its weight falling from 6.35% in

1990 to 5.47% in 1994, also lower than the 6.24% of 1980. This reveals a strong crisis in the sectors of the block, which detains its modernisation process. This can be confirmed with the data from Table 2.

Finally, the Construction block maintains its weight over the 14 years, going from 7.56% to 7.50% and the evolution of its I_s and B_s follow the general pattern. Nevertheless, unlike the majority, in this block F_s suffers an important fall from 22.51% in 1980 to 16.91% in 1994, having been 15.42% in 1990. This indicates that it closes in on itself even more intensely than other blocks.

3.3. Technological and demand effects of the different blocks

The results of the SDA are found in Tables 2 and 3 as percentages. The analysis for the three successive periods, 1980-86, 1986-90 and 1990-94 can be seen in Table 2, and a similar analysis can be seen in Table 3 for the whole period 1980-94.

Tables 2 and 3 give a similar picture to that obtained with Table 1 about the sectorial growth rhythms of the economy. The economy has a permanent increase in production of approximately 3% annually and the blocks with greater growth from 1980 to 1994 are High Technology, Medium-high Technology, High Qualification Services and Other Services. In the first period, from 1980 to 1986, only these four and Primary are above the average. From 1986 to 1990 we find the original 4 blocks except Other services with the addition of Construction. From 1990 to 1996, it is High Technology that goes through a crisis and its place is taken by Low Technology. We can also see that of the three blocks that lose weight significantly between 1980 and 1994, Primary, Energy and Medium-low Technology, only Primary has a higher than the average growth in the economy in any of the sub-periods and, even then, only in the first, from 1980 to 1986.

If we look at the values of the effects, the first thing that we observe is that almost all the demand effects are positive both for the whole period and for the three sub-periods. Only Energy and Medium-low technology present any negative figures, which reflect the strong loss of weight of these blocks which we have already mentioned. The positive sign of these effects is coherent with the high growth rates of the economy in these years. Furthermore, their values in High Technology, Medium-high Technology, High Qualification Services and Other Services confirm that an important part of the growth of the Spanish economy has been due to demand factors.

On the other hand, and given that a technological change means a reduction in unitary costs in inputs, we should expect negative values in some of the technological effects and especially in the technological effect of I_s+M_s+B_s because it measures the global technological change of the productive techniques of G_s. Equally, as we have seen that the dominant pattern of structural change has been an increase in the activity of the block itself and a weakening of the links with the others, we should expect the technological effects of B_s to be bigger than those of I_s, because of the substitution effects.

If we look at Table 3 we see that, from 1980 to 1994, all the blocks except Energy and High qualification services, the two blocks with the most anomalous evolution, have a negative technological effect of I_s+M_s+B_s, this effect being, for the total economy, -4.73%. Furthermore, for the total economy, that of I_s is positive, 1.56%, while that of B_s is –6.43%. Thus we can say that the Spanish economy as a whole underwent an intense process of technological change with a dominant pattern, the increase of the activity within the block and the weakening of the external purchases.

Table 2 confirms this conclusion, but shows that the modernisation has not been constant or homogenous. For the Spanish economy, only the technological effects of

M_s, B_s, I_s+M_s+B_s and F_s are negative in the first sub-period, from 1980 to 1986, all the technological effects are positive in the second from 1986 to 1990 and only those of I_s, B_s, I_s+M_s+B_s and F_s are negative in the third. The technological effect of I_s+M_s+B_s is also of -4.05% in 1980-86, as opposed to values of 0.97% and -0.75% in the other two sub-periods. In other words, the Spanish economy underwent an intense technological change, especially in the periods 1980-86 and 1990-94, but in the intermediate period, 1986-90, this process is detained and even recedes. The lack of homogeneity and constancy can also be seen in the data by blocks, where from 1980 to 1986 we have 8 of the 9 blocks with a negative technological effect in I_s+M_s+B_s, whereas only 3 of them have this sign in the second sub-period and 6 from 1990 to 1994.

To extend the analysis at the block level, we are going to look in more detail at 4 of them: High technology, Medium-low technology, High qualification services and Other services. The first two are very representative of the blocks that have incorporated technological change to a high degree, the second two of those that have had lesser improvements or even a decrease in efficiency. If the reader is interested, he can extend the analysis to the other blocks using Tables 2 and 3.

The Medium-high technology is the block that presents the most regular growth of x_s throughout the three periods, with increases of 29.23%, 22.89% and 21.28%. As was to be expected, all its demand effects are positive, the majority being above the average of the economy. Its technological effects of F_s (sales of inputs) are always positive, revealing that their products are more demanded by other sectors which thus receive, indirectly, the technological improvements of the block. In this block, the technological effects of B_s are always negative and those of I_s are less than those of B_s (larger in figures) confirming that it follows the general pattern of structural change of

the blocks. Moreover, if we look at the technological effects of I_s+M_s+B_s in the three sub-periods, -8.84%, 0.25% and -4.69%, we can affirm that the change was produced principally in the years 1980-86, the years 1986-90 being those of least change.

Medium-low technology is a block that loses weight in the economy, going from 16.36% to 10.27% (according to the data of Table 1), but which, nevertheless, presents an intense technological change, the technological effect of I_s+M_s+B_s from 1986 to 1994 is –19.64%, with sub-period values of –14.57%, 1.71% and -4.02%, respectively. We can also observe that its demand effects of F_s are high, 14%, 13.92% and 11.08%, always higher than the Spanish average. This allows us to say that this block has suffered an important crisis that it has overcome through technological transformation, based on its sales to other blocks. Remember that in this block there are sectors such as Cement, Metallic products and Plastic products.

The High Qualification Services block presents a different evolution. This block coincides with Medium-high technology in its fast and permanent growth, with increases of 36.19%, 16.54% and 19.64% respectively. Equally, all its demand effects and technological effects of F_s are always positive. However, its technological effect of I_s+M_s+B_s in the whole period, from 1980 to 1994, is positive, being 38.08% of its V_s. Also, from 1980 to 1994 all its backward technological effects are positive. The same can be said of the first two sub-periods, only from 1990-94 does it present a negative technological effect of I_s+M_s+B_s of -0.5% and a negative technological effect of I_s of -4.43%. So we can say that the block does not improve its own technological efficiency, growing, more than anything, through an increase in demand. The negative figures of the years 1990-94 show a change in the trend through savings in its own inputs.

And, finally, the Other services block also presents a permanent growth, with increases in the three sub-periods of 27.13%, 7.49% and 17.2%. All its demand effects are positive, which tells us that its production is required by other blocks and that demand plays an important role in its growth. However, this block has a positive technological effect of $I_s+M_s+B_s$ both in 1986-90 and in 1990-94, the value for the period 1980-1996 being –1.25%. In short, since 1986 its technological efficiency has been falling and, the same as happened in the High qualification services block, the technological improvements in the whole period have been small. This revealed the necessity in 1994 (at the end of the period) of an important transformation of the service sectors to allow them to improve their competitiveness and to save on costs.

Conclusions

Although the main results have already been presented, we wish to close this analysis by commenting on some of the instruments used and the features that characterise the evolution of the Spanish economy in the period 1980- 1994.

In the first place, the paper shows the possibilities of the instruments used: input-output analysis by blocks, vertical integration, Structural Decomposition Analysis and Generalised linkage indicators, to go more deeply into the factors that explain structural change and technological change in an economy. Vertical integration allows us to capture both the direct and indirect sectorial interdependencies. Working by blocks enables us to identify the character (demander or supplier) that a group of sectors has in its relationships both with the rest of the economy and between the sectors that compose it. The linkage components defined for each block and their corresponding indicators give a clear and simple view of the sales and purchases of each block and, thus, of their interdependencies. Finally, the application of the SDA to

the production divided into four components for each block allows us to identify four technological effects and four demand effects per block and to better describe the changes in the economy.

From an empirical point of view, the application of these instruments to the Spanish economy shows, in the first place, an important growth and structural change in the 80s and the early 90s. This change is seen, above all, in the greater participation in production of the High technology and Medium-high technology blocks as well as in all types of services, and is accompanied by a reduction in the weight of the Primary, Energy and Medium-low technology blocks. A first look at this change reveals, nevertheless, that the greater orientation towards technology intensive sectors has not been accompanied by a greater integration between the blocks.

Moreover, the application of the SDA allows us to identify and quantify two explanatory factors of this evolution: the constant growth of the demand and the technological change.

The weight of the demand factors in the growth is high, especially in the period 1986-90, which can be seen in the positive signs of almost all the demand effects. Nevertheless, looking more carefully, we can see, among other things, a demand crisis in High Technology and in Construction in the years 1990-94 and in Other services between 1986 and 1990.

The technological change is especially intense in the years 1980-86, in which all the backward technological effects are negative except those of High qualification services. The technological transformation weakens between 1986 and 1990 and recovers with less intensity in the final years of the period. Although the technological change has not been uniformly distributed among the blocks, we find a significant regularity. Almost always, the technological change associated with the backward

component B_s is higher (lower in figures) than that associated with the forward component I_s. This is nothing more than the reflection of a strong process of substitution, that is a constant of the structural change of the period, and that leads to a strengthening of the activities within each block compared to the extra-block activities.

Finally, one of the most surprising data of the technological change in Spain in this period is its evolution in the service sectors. Both High qualification services, and Other services have a strong and constant growth throughout the period that is not reflected in a parallel improvement in its productive efficiency. Its growth is due more than anything to the demand effects, which suggests that there is still a strong transformation pending in the activities of services in the Spanish economy, whether it be in tourism, aids to business or activities associated with information technology. As a final comment we can say that the Spanish economy has undergone a dual evolution, an important modernisation in some sectors and a process of increasing the service sectors with little improvement in efficiency. The future will probably depend on which of these two facets dominates.

4. References

BBV, 1999. Renta nacional de España y su distribución provincial. Serie homogénea. Años 1955 a 1993 y avances 1994 a 1998. Fundación BBV, Bilbao

Blair, P.D., and Wyckoff, A.W., 1989. The changing structure of the U.S. Economy: An input-output analysis. In R.E. Miller, K.R. Polenske amd A.Z. Rose (eds.), Frontiers of Input-Output Analysis. Oxford University Press, New York, pp. 293-307.

Carter, A.P., 1970. Structural Change in the American Economy. Harward University Press, Cambridge.

Cella, G., 1984. The input-output measurement of interindustry linkages. Oxford Bulletin of Economics and Statistics 46, pp. 73-84.

Dietzenbacher, E. and Los, B. 1998. Structural decomposition techniques: sense and sensivity. Economic Systems research, 10, 307-323.

Guccione, A. (1986) The input-output measurement of interindustry linkages: A comment, Oxford Bulletin of Economics and Statistics, 48, pp. 373-377.

Miller, R.E. and Lahr, M.L. 2001. A taxonomy of extractions. In M.L. Lahr and R.E. Miller (eds) Regional Science Perspective in Economic Analysis. Elsevier Science, Amsterdam.

Pasinetti, L.L., 1973. The Notion of Vertical Integration on Economic Analysis. Metroeconomica 25, 1-29

Pasinetti, L., 1975. Lezioni di teoria delle produzione. Ed. Società Editrice il Mulino, Bologna.

Pasinetti, L., 1977. Lectures on the Theory of Production. Macmillan, London

Peterson, W., 1979. Total factor productivity in the UK: A disaggregated analysis. In K.D. Patterson and K. Schott (eds) The Measurement of Capital: Theory and Practice. Macmillan, London.

OECD 2001. Tableau de bord de l'OECD de la science, de la technologie et de l'industrie. OECD. París.

Rose, A. and Casler, S. 1996. Input-Output Structural Decomposition Analysis: A Critical Appraisal. Economic Systems Research, 8, 33-62.

Rose, A. and Chen, C.Y. 1991. Sources of change in energy use in the US economy, 1972-1982: a structural decomposition analysis. Resources Energy, 13, 1-21.

Sánchez Chóliz, J. and Duarte, R. 2003. Production chains and linkage indicators. Economic Systems Research 15, 4, 481-494.

Skolka, J. 1989. Input-Output Structural Decomposition Analysis for Austria. Journal of Policy Modelling, 11, 45-66.

Wolf, E. 1985. Industrial composition, interindustry effects and the U.S. productivity slowdown. Review of Economics and Statistics, 67, 268-277.

Table 1. Decomposition of Production x_s and Vertically Integrated Production V_s of the blocks into four components (percentages)

Year	Ratios	Primary	Energy	High Technology	Medium-high Technology	Medium-low Technology	Low Technology	Construction	High qualification Services	Other services	Spanish economy
1980	x_s / x	6.24	3.89	2.50	6.34	16.36	16.78	7.56	11.32	29.01	100.00
	V_s / x_s	48.10	-147.11	103.99	105.37	55.71	138.70	171.55	69.63	138.60	100.00
	I_s / V_s	53.64	62.13	46.82	45.54	52.41	51.77	44.81	78.61	63.13	56.53
	M_s / V_s	3.92	2.38	0.4	2.36	6.22	3.59	0.36	1.33	1.69	2.38
	B_s / V_s	42.44	35.49	52.78	52.10	41.37	44.64	54.83	20.06	35.18	41.09
	F_s / V_s	72.31	194.90	50.90	49.52	67.33	23.21	22.51	44.34	10.16	41.09
1986	x_s / x	6.36	3.10	3.08	7.11	11.39	16.48	7.05	13.39	32.02	100.00
	V_s / x_s	42.73	-31.44	78.37	93.87	40.55	134.48	160.82	67.35	131.21	100.00
	I_s / V_s	57.40	67.23	56.19	47.29	60.98	51.95	49.70	78.95	66.83	60.59
	M_s / V_s	4.75	1.35	0.48	3.13	3.23	3.82	0.44	1.48	1.82	2.28
	B_s / V_s	37.85	31.42	43.33	49.58	35.79	44.23	49.86	19.57	31.35	37.13
	F_s / V_s	73.44	121.56	55.59	52.67	73.96	25.00	19.37	45.83	9.92	37.13
1990	x_s / x	6.35	2.74	3.35	7.82	10.76	16.00	8.21	13.96	30.80	100.00
	V_s / x_s	39.43	-28.15	79.75	93.84	29.03	128.88	169.71	68.95	132.92	100.00
	I_s / V_s	60.13	42.26	56.71	47.82	60.02	52.14	49.44	77.58	65.67	60.08
	M_s / V_s	4.65	0.68	0.5	3.61	3.29	3.7	0.4	1.68	1.75	2.19
	B_s / V_s	35.22	57.06	42.79	48.57	36.69	44.16	50.16	20.74	32.58	37.73
	F_s / V_s	74.45	112.09	54.37	51.73	81.62	28.03	15.42	45.35	10.39	37.73
1994	x_s / x	5.47	2.65	3.17	8.28	10.27	16.60	7.50	14.58	31.50	100.00
	V_s / x_s	43.27	-19.67	75.55	91.87	33.29	122.00	164.68	72.60	131.93	100.00
	I_s / V_s	55.64	30.81	56.80	49.14	62.44	53.74	50.05	73.54	65.72	60.54
	M_s / V_s	4.66	0.38	0.52	3.67	2.99	3.94	0.4	2.03	1.9	2.35
	B_s / V_s	39.70	68.81	42.68	47.19	34.57	42.32	49.55	24.43	32.38	37.11
	F_s / V_s	73.91	106.14	56.70	51.48	78.22	29.64	16.91	45.14	10.79	37.11

Abbreviations: $x_s = \mathbf{u_s}' \mathbf{x_s}$ = total output of block G_s, $x = \mathbf{u}' \mathbf{x}$ = total output, V_s = Value of the Vertically Integrated Production of block G_s, I_s = Internal indicator of block G_s, M_s = Mixed indicator of block G_s, B_s = Backward indicator of block G_s, F_s = Forward indicator of block G_s.

Table 2. Structural Decomposition Analysis of the production x_s and Vertically Integrated Production V_s of the blocks for three sub-periods of 1980-1994

	Value of the ratio in percentages	Primary	Energy*	High Technology	Medium-high Technology	Medium-low Technology	Low Technology	Construction	High qualification Services	Other services	Spanish economy
80/86	(Total change in x_s)/x_s	17.3	-8.19	41.9	29.23	-19.78	13.09	7.43	36.19	27.13	15.15
	(Total change in V_s)/V_s	4.2	-80.38	6.95	15.12	-41.61	9.65	0.71	31.72	20.35	15.15
	(Technological effect of I_s)/V_s	-0.26	-3.03	-0.59	-1.72	-3.83	-2.12	0	21.97	0.93	1.3
	(Technological effect of M_s)/V_s	0.52	-0.22	0.04	0.50	-3.04	0.28	0.03	0.48	0.07	-0.08
	(Technological effect of B_s)/V_s	-7.67	-7.3	-13.59	-7.12	-10.74	-1.31	-10.45	3.8	-5.89	-5.35
	(Technological effect of I_s+ M_s+ B_s)/V_s	-7.93	-10.33	-14.18	-8.84	-14.57	-3.43	-10.45	25.77	-4.96	-4.05
	(Technological effect of F_s)/V_s	6.1	90.27	13.98	8.07	-22	-0.22	-4.71	5.79	0.9	-5.35
	(Demand effect of I_s)/V_s	6.43	45.9	13.87	10.62	-12.98	7.31	5.25	3.41	16.37	11.94
	(Demand effect of M_s)/V_s	0.50	1.90	0.07	0.73	-1.29	0.32	0.04	0.14	0.44	0.32
	(Demand effect of B_s)/V_s	4.67	22.02	7.16	12.1	-9.73	5.16	5.84	1.92	8.43	7.01
	(Demand effect of F_s)/V_s	7.73	-6.98	14.01	10.48	14	5.27	3.01	12.29	1.54	7.01
86/90	(Total change in x_s)/x_s	11.65	-1.44	21.43	22.89	5.5	8.49	30.06	16.54	7.49	11.74
	(Total change in V_s)/V_s	3.03	-11.77	23.57	22.86	-24.46	3.97	37.25	19.31	8.89	11.74
	(Technological effect of I_s)/V_s	-0.95	3.14	-0.55	0.67	-0.49	-0.15	0	1.84	0.54	0.31
	(Technological effect of M_s)/V_s	-0.40	-0.06	-0.01	0.62	0.26	-0.19	-0.04	0.32	-0.02	0.02
	(Technological effect of B_s)/V_s	-4.99	35.01	-3.26	-0.42	2.2	-0.66	0.67	2.56	2.32	0.66
	(Technological effect of I_s+ M_s+ B_s)/V_s	-5.94	38.15	-3.81	0.25	1.71	-0.81	0.67	4.4	2.86	0.97
	(Technological effect of F_s)/V_s	4.75	15.21	2.11	5.6	-1.77	2.98	0.01	1.24	-0.29	0.66
	(Demand effect of I_s)/V_s	5.5	33.08	14.43	10.79	-15.15	2.4	18.15	11.77	4.13	6.23
	(Demand effect of M_s)/V_s	0.44	0.68	0.15	0.69	-1.01	0.22	0.15	0.20	0.10	0.15
	(Demand effect of B_s)/V_s	3.43	16.09	12.79	10.5	-10.28	2.34	18.32	2.61	1.81	4.38
	(Demand effect of F_s)/V_s	4.93	-4.12	8.33	5.3	13.92	2.43	0.68	5.78	1.54	4.38
90/94	(Total change in x_s)/x_s	-1.37	10.75	8.41	21.28	9.44	18.86	4.71	19.64	17.2	14.61
	(Total change in V_s)/V_s	8.24	-22.58	2.7	18.74	25.48	12.51	1.6	25.97	16.33	14.61
	(Technological effect of I_s)/V_s	-0.72	1.5	0.01	-0.44	-0.46	-0.19	0	-4.43	0.51	-0.33
	(Technological effect of M_s)/V_s	0.33	0.07	0.01	-0.21	-0.54	0.40	-0.01	0.38	0.17	0.16
	(Technological effect of B_s)/V_s	7.23	7.9	-0.58	-4.25	-3.56	-1.53	-1.24	3.93	0.02	-0.42
	(Technological effect of I_s+ M_s+ B_s)/V_s	6.51	9.4	-0.57	-4.69	-4.02	-1.72	-1.24	-0.5	0.53	-0.75
	(Technological effect of F_s)/V_s	-7.5	11.75	-1.97	3.47	-7.1	2.95	-0.38	1.74	0.82	-0.42
	(Demand effect of I_s)/V_s	0.81	19.91	1.61	10.97	18.8	8.52	1.42	19.49	10.27	9.65
	(Demand effect of M_s)/V_s	0.07	0.46	0.02	0.95	1.00	0.33	0.01	0.50	0.28	0.34
	(Demand effect of B_s)/V_s	0.53	11.68	1.63	11.71	10.25	4.99	1.42	6.11	5.07	5.22
	(Demand effect of F_s)/V_s	5.95	-17.21	9.06	7.24	11.08	4.25	2.67	6.92	1.44	5.22

* The signs of the demand and the technological effects of F_s of the Energy block have been changed to help their interpretation, because their V_s is negative.

Blocks: 1: Primary block; 2: Energy block; 3: High Technology block; 4: Medium-high Technology block; 5: Medium-low Technology block; 6: Low Technology block; 7: Construction; 8: High qualification Services; 9: Other services

Abbreviations: x_s = $\mathbf{u_s'}\,\mathbf{x_s}$ = total output of block G_s, x = $\mathbf{u'}\,\mathbf{x}$ = total output, V_s = Value of the Vertically Integrated Production of block G_s, I_s = Internal indicator of block G_s, M_s = Mixed indicator of block G_s, B_s = Backward indicator of block G_s, F_s = Forward indicator of block G_s.

Table 3. Structural Decomposition Analysis of x_s and Vertically Integrated Production V_s of the blocks for 1980-1994

	Value of the ratio in percentages	Primary	Energy*	High Technology	Medium-high Technology	Medium-low Technology	Low Technology	Construction	High qualification Services	Other services	Spanish economy
80/94	(Total change in x_s)/x_s	29.17	0.22	86.80	92.61	-7.38	45.83	46.31	89.89	60.15	47.48
	(Total change in V_s)/V_s	16.20	-86.60	35.72	67.94	-44.66	28.26	40.45	97.97	52.45	47.48
	(Technological effect of I_s)/V_s	-1.92	-1.77	-1.10	-1.86	-5.08	-2.57	0.00	23.17	2.24	1.56
	(Technological effect of M_s)/V_s	0.47	0.18	0.05	1.17	-3.19	0.52	-0.01	1.54	0.26	0.14
	(Technological effect of B_s)/V_s	-6.04	10.16	-20.23	-14.37	-11.37	-4.08	-13.45	13.38	-3.75	-6.43
	(Technological effect of I_s+ M_s+ B_s)/V_s	-7.49	8.58	-21.28	-15.05	-19.64	-6.12	-13.46	38.08	-1.25	-4.73
	(Technological effect of F_s)/V_s	2.96	126.31	16.98	20.96	-33.31	6.03	-5.86	8.20	1.72	-6.43
	(Demand effect of I_s)/V_s	12.93	-56.24	31.38	38.85	-12.78	19.72	25.49	43.80	34.82	31.20
	(Demand effect of M_s)/V_s	1.01	-2.51	0.24	2.62	-1.37	0.94	0.20	1.15	0.94	0.94
	(Demand effect of B_s)/V_s	9.74	-36.43	25.38	41.52	-10.87	13.73	28.21	14.93	17.94	20.07
	(Demand effect of F_s)/V_s	20.20	-37.78	38.03	28.68	38.42	13.97	8.10	33.19	5.40	20.07

* The signs of the demand and the technological effects of F_s of the Energy block have been changed to help their interpretation, because their V_s is negative.

Blocks: 1: Primary block; 2: Energy block; 3: High Technology block; 4: Medium-high Technology block; 5: Medium-low Technology block; 6: Low Technology block; 7: Construction; 8: High qualification Services; 9: Other services

Abbreviations: x_s = $\mathbf{u_s'}\,\mathbf{x_s}$ = total output of block G_s, x = $\mathbf{u'}\,\mathbf{x}$ = total output, V_s = Value of the Vertically Integrated Production of block G_s, I_s = Internal indicator of block G_s, M_s = Mixed indicator of block G_s, B_s = Backward indicator of block G_s, F_s = Forward indicator of block G_s.

[i] The concept of the vertically integrated sector, although initially formulated by Pasinetti, has been used by many economists, for example Peterson (1979) or Wolf (1985), to describe and quantify the processes of productive integration and the linkages between sectors.

[ii] Technological change in the input-output models is associated with changes in the coefficients. But it should never be forgotten that these changes involve true technological changes as well as changes in input coefficients due to input substitution and complementarity.

[iii] $\mathbf{u}_s'$ is an $1 \times m$ vector of ones, where m represents # of sectors of G_s,