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Abstract

In this paper we measure, at sectoral level, the sources of Spanish productivity growth, distinguishing among the roles played by labor productivity, the degree of factor substitution and total factor productivity (Solow residual). In terms of value added, total factor productivity growth in the manufacturing sector is higher than in services (2.4% and 1.1% respectively), although the Communication Sector constitutes an exception. In terms of gross production productivity growth in both sectors is virtually the same (0.6% and 0.7% respectively) because of the relative lower weight of intermediate inputs in producing services. During the latest cyclical expansion, 1995-1999, we have observed a marked deceleration in labor productivity, associated to an increase in employment, and to a deceleration in the capital-labor ratio, while total factor productivity has remained more stable.

1. Introduction

The study of the sources of growth is a key element in the characterization not only of the potential output of an economy, but also of how cost pressures are transmitted to final prices. Generally, the productivity concept used in this context is labor productivity, that is, the volume of production per unit of labor. This way of measuring productivity only considers one productive factor. In the presence of substitution effects among factors, it would be a biased indicator of the technological progress. In fact, the growth rate of an economy will depend not only on the changes in the productive factors, their costs and the degree of substitution among them, but also on an independent component. This component is known as technological progress or total factor productivity.

The aim of this paper is to identify the sources of Spanish growth, distinguishing among the roles played by labor productivity, the degree of factor substitution and total factor productivity (Solow residual), as a proxy for technological progress. At the same time, we stress the growth of productivity at a more disaggregated level. In order to analyze these aspects, we construct a sectoral homogeneous data base that allows us to obtain more precise calculations of technological progress. In this data set we collect information from different sources (compatible with the National Accounts estimates for 1980-1995) for seventeen branches of activity. As a whole, these branches constitute the market economy excluding the financial system. At the same time, we incorporate more recent information on those branches, to analyze the behavior of the Spanish economy in the last four years (1996-1999). The latter exercise should be taken as provisional (it is based on sectoral indicators), and may be affected as more National Accounts information becomes available.

The structure of the paper is as follows. In the section 2 we outline some theoretical issues related to the measurement of the productivity growth. In section 3 we describe the data set, in terms of both the available information and the way it has been constructed. In sections 4 and 5 we present some stylized facts describing the sources of productivity growth and, finally, we present some conclusions.

2. Measuring Productivity Growth: Production versus Value Added

Let us assume that, without loss of generality, at time t and for the firm i, the production function for gross output (Y_{it}) as follows:

$$Y_{it} = F(K_{it}, L_{it}, M_{it}, A_{it}) \qquad (1)$$

where K, L, M and A represent capital, labor, intermediate inputs and an index of technology respectively. Assuming that this function is homogeneous of degree one in the

productive inputs (i.e. it exhibits constant returns to scale) and differentiable in its four arguments, the logarithmic differentiation of this function implies that:

$$\Delta y_{it} = \frac{F_{Kit} K_{it}}{Y_{it}} \Delta k_{it} + \frac{F_{Lit} L_{it}}{Y_{it}} \Delta l_{it} + \frac{F_{Mit} M_{it}}{Y_{it}} \Delta m_{it} + \Delta a_{it} \qquad (2)$$

where $\Delta x_{it} \equiv \Delta \log x_{it}$ *for* Y, K, L, M *and* A, and F_x captures the corresponding marginal productivity. This expression implies that the growth rate of gross production will be a weighted average of the growth rates of the inputs, the weights being their elasticity in the production function plus the growth rate of the technological index. Notice that, apart from this last index, all the variables are known except the marginal productivities, so if we can relate these variables to other observable ones, we can obtain estimates for the technological index.

In order to do that, we consider the first order conditions of the cost minimization problem of the typical firm. These conditions imply that the firm will set the marginal product in nominal terms of each input equal to the price of that input (we are assuming perfect competition in the product market):

$$P_{xit} = F_{xit} P_{it}, \quad x = K, L, M \qquad (3)$$

where P_x is the price of the corresponding input. Substituting this condition in the previous one we obtain:

$$\Delta y_{it} = s^F_{Kit} \Delta k_{it} + s^F_{Lit} \Delta l_{it} + s^F_{Mit} \Delta m_{it} + \Delta a_{it} \qquad (4)$$

with $s^F_{xit} = \frac{P_{xit} x_{it}}{P_{it} Y_{it}}$, $x = K, L, M$, i.e. the share of the cost of each of the inputs over total income. These shares can easily be calculated from our data set. Under perfect competition these income shares must adding up to one, but this is not the case under imperfect competition, i.e. due to the existence of pure profits. Thus, to make the calculation of total factor productivity robust to that circumstance, we can reformulate this expression in terms of total costs ($c^F_{xit} = \frac{P_{xit} x_{it}}{\sum_x P_{xit} x_{it}}$, $x = K, L, M$). Hence, the total factor productivity can be obtained as follows:

$$\Delta a_{it} = \Delta(y_{it} - l_{it}) - (1 - c^F_{Lit}) \Delta(k_{it} - l_{it}) - (1 - c^F_{Lit} - c^F_{Kit}) \Delta(m_{it} - l_{it}) \qquad (5)$$

Thus, technology growth accounts not only for labor productivity, but also for the capital-labor ratio, the intermediate inputs-labor ratio and the cost shares to define true productivity growth. While this is the right approximation when analyzing productivity at the firm (sectoral) level, at aggregate level the consideration of gross production involves double counting of the intermediate consumption, so it is necessary to eliminate these inputs to define value added (V_{it}). We proceed to define the production function in terms of value added (using only two productive factors: capital and labor) to obtain an expression for total factor productivity growth (A^v) as follows:

$$\Delta a_{it}^{v} = \Delta(v_{it} - l_{it}) - (1 - c_{Lit}^{v})\Delta(k_{it} - l_{it}) \tag{6}$$

As expected, the intermediate consumption-labor ratio has disappeared from that expression and the labor cost share (c^v_L) is now calculated using value added costs, i.e. excluding the intermediate consumption costs. This value-added technological growth rate will, in general, not be equal to the one calculated using gross production. The relation between them can be derived as follows. Value added growth, in real terms, is calculated using a double-deflation procedure:

$$\Delta v_{it} = \frac{\Delta y_{it} - s_{Mit}^{F}\Delta m_{it}}{1 - s_{Mit}^{F}} \tag{7}$$

and substituting the growth rate of gross production from (4) we obtain:

$$\Delta v_{it} = \frac{s_{Kit}^{F}}{1 - s_{Mit}^{F}}\Delta k_{it} \cdot \frac{s_{Lit}^{F}}{1 - s_{Mit}^{F}}\Delta l_{it} + \frac{1}{1 - s_{Mit}^{F}}\Delta a_{it} \tag{8}$$

Using again the cost shares instead of the income shares (due to the possible existence of pure profits), it is clear that, comparing this expression with (6), the relationship between total factor productivity measured in terms of value added and in terms of gross production is the following:

$$\Delta a_{it}^{v} = \frac{1}{1 - c_{Mit}^{F}}\Delta a_{it} \tag{9}$$

Thus, the growth rate of total factor productivity in terms of value added will always be higher than in terms of gross production (provided Δa_{it} is positive), and the difference will depend on the intensity of the use of intermediate inputs (c_{Mit}^{F}).

3. The data set

Since we are interested in analyzing productivity from both an aggregate and a disaggregated perspective, one requirement for the data set is a certain degree of comparability with the figures produced by the *Instituto Nacional de Estadística* (INE) in the framework of the National Accounts for the whole economy.

3.1. Construction of the variables and data sources

Our data set consists of yearly information on seventeen productive branches over the period 1980-1995. These productive branches include ten manufacturing sectors, four market service sectors, and the Agricultural, Energy and Construction Sectors, whose exact definitions are summarized in Table 3.1. The aggregation of these sectors corresponds to the non-financial market Spanish economy. We exclude non-market services from the analysis because, as they are not traded on a market, their output and prices can be thought of as accounting conventions. In the case of the financial sector the problem lies in the difficulty of measuring its activity appropriately.

For each of these seventeen sectors we compile information for the following variables:

1 Gross production, it is defined as the sum of intermediate consumption and value added at factor cost.

2 Intermediate consumption. We distinguish between: energy and non-energy inputs and domestic and imported intermediate goods and services.

3 Value added at factor cost, is defined as the sum of compensation of employees and the gross operating surplus.

These variables, in nominal terms, are taken from the National Accounts Statistics. One problem we encounter is that our sample period covers three different base years (1980, 1986 and 1995). In order to have homogeneous time series for the full period we proceed as follows: first, we aggregate the original (more disaggregated) sectors to obtain similar coverages for the three base years, and, second, we link together the three series. This last requirement is achieved using a statistical method similar to that proposed in Corrales and Taguas (1989). First we link aggregate gross production using the growth rates of the two earlier series. Then, sectoral gross production figures are generated, again using their corresponding growth rates, but now correcting their levels in order to match the aggregate gross production obtained in the previous step. Once we have the sectoral gross production, sectoral intermediate consumption and value added are extended backwards using growth rates and correcting their levels in order to match the previous

sectoral gross production. The same is done with compensation of employees and the gross operating surplus[1].

The deflators of sectoral gross production are generated by combining different price indicators. In the case of the Agricultural, Energy and Manufacturing sectors, the deflator is a chained weighted index of agricultural and industrial domestic prices and unit value indexes for exports, all of them corrected for indirect taxation. The weights are calculated using several Input-Output Tables. In the case of Construction we use the deflator of gross capital formation, and for the market service sectors the corresponding categories of consumer prices (corrected for indirect taxation)[2]. Using these gross production deflators and unit value indexes for imports, we are able to calculate chained weighted price indexes for sectoral intermediate consumption. As in the previous case, the weights come from Input-Output Tables. Once we have calculated gross production and intermediate consumption in real terms it is straightforward to obtain sectoral value added in real terms and the corresponding deflators.

In addition, we obtain information for two other productive inputs.

4 Labor, including number of employees, total employment and hours per employee

5 Capital stock

The number of employees and total employment are taken from the National Accounts Statistics, and, as in the previous case, a similar linking method is used to extend the sectoral figures backwards. Hours per employee are taken from the Wage Survey, and homogenized to adjust for various methodological changes.

By dividing compensation of employees by the number of employees we obtain compensation per employee. This variable allows us to calculate what we called compensation of total employment, as the sum of compensation of employees and the imputed compensation of self-employees. The latter is defined as the product of compensation per employee and the number of self-employees (i.e., the difference between total employment and number of employees) corrected by a factor that captures the relative weight of the social contributions of employees and self-employees. Thus we end up with a corrected measure of the gross operating surplus (i.e., the difference between the value added and the compensation of total employment), which is free from the effects of differences in the relative importance of self-employment across sectors. In general, the wage concept that we use in this paper is compensation per total employment

[1] The gross operating surplus of Other Market Services is corrected for the housing services imputed to home-owners, that, again, are not traded.

[2] For a detailed description of the indicators used, you can see Estrada, Perea, Urtasun and Briones (1998).

(per hour), that is, the ratio of compensation of total employment to total employment (total employment multiplied by hours per employee).

Finally, the capital stock is calculated using the permanent inventory method on sectoral investment series (see, for example, Hulten and Wykoff (1981)). These investment time series in real (and nominal terms) are taken from BBVA Foundation Regional Data Base and adapted to ESA-95 requirements. In order to apply the permanent inventory method, we still need an initial condition for the capital stock and a depreciation rate. Both variables are also taken from the BBVA Foundation Regional Data Base. For each sector s, the price of the capital stock is defined as a user cost (uc) as follows:

$$uc_s = p_{Is}\left[i(1-\tau)+\delta_s-\pi_{Is}\right]\frac{(1-d-\tau z_s)}{1-\tau} \qquad (10)$$

where p_I is the implicit investment deflator, i is the nominal interest rate (a weighted average of the interest rates of different credit instruments, see Cuenca (1994)), τ the marginal profit tax rate, δ_s the sectoral depreciation rate, π_I investment price inflation, d the investment allowances and z the fiscal savings associated with capital depreciation. The product of this user cost of capital and the capital stock is capital income, and, finally, the difference between the corrected gross operating surplus and the income of capital gives us an estimation of pure profits.

Finally, due to the delay in publication of the National Accounts sectoral estimates for output and inputs, we can not extend the data set using the same sources from 1995 onwards. Hence we have to resort to some other data sources to extend the original data base to 1999[3]. Although these estimates should be seen as provisional and subject to the usual revision process, in the section 5 we try to shed some light on the recent behavior of Spanish productivity.

3.2. Relationship with National Accounts aggregates

Recently, the *Instituto Nacional de Estadística (INE)* has extended, in the ESA-95 framework, the main macroeconomic aggregates back to 1980. Before presenting some stylized facts characterizing the joint evolution of the real variables compiled in the previous section, we think it is interesting to compare our aggregate (resulting from the aggregation of the seventeen sectors) with the figures for the market economy given by INE (note that these figures also include the financial sector).

[3] To give just a few examples, gross production in real terms was enlarged using indicators of industrial production, transportation, hotels ad catering, etc; intermediate consumption and sectoral investment using the Encuesta Industrial; employment using the Labor Force Survey; compensation per employee using the Encuesta de Salarios. All the sectoral figures were made compatible with the figures estimated by the National Accounts for the market economy.

Figure 3.1.A shows the growth rates of GDP, in real terms, according to the National Accounts (continuos line) and value added according to our aggregate (dotted line). In addition to the inclusion of the financial sector, the National Accounts value added also includes the imputed income of home owners and is defined at basic prices, as opposed to our value added which is at factor cost. In spite of this, from 1987 the profiles of the two series are quite similar, but before 1987 there are some sizeable short-run discrepancies (e.g. 1985)[4]. Figure 3.1.B shows that the profiles for total employment according to these two sources are almost coincident. In figure 3.2 we compare two price variables: the value added deflator (panel A) and the compensation per employee (panel B). The profiles for the value added deflator are quite similar and the differences are explained by taxation considerations. In the case of compensation per employee the differences are even less important.

Thus, as we expected, our data base constitutes a reasonable proxy for National Accounts aggregates, with the advantage that it has a certain degree of sectoral dissagregation and includes some variables not calculated in the National Accounts framework (such as hours, capital stocks and user costs of capital among others).

4. Technological characteristics of the Spanish economy. Some stylized facts: 1980-1995

In this section we describe the evolution of the different components of productivity. In particular, we describe the paths of the output and input indicators that we have constructed for each sector, with the aim of analyzing its contribution to the behavior of labor productivity and its cyclical behavior. Labor productivity is an imperfect proxy for technological progress since it disregards important aspects that could bias the identification of true technological progress. To mention some of these factors, one might consider the importance of changes in the relationship between labor and other inputs, the different degree of intensity in the use of inputs, and the degree of competition in the goods and input markets. Accordingly, it seems necessary to construct a more sophisticated measure of technological growth. A first step in this direction is the calculation of the so-called Solow residual (p) as a measure of total factor productivity (TFP). Although this is a step forward in the identification of the sources of technological growth, as we saw, its calculation also involves a number of assumptions, including a production function with constant returns to scale, a constant relative utilization of the productive factors and perfect competition in the output and input markets.

Finally, in all the analysis presented in this paper, instead of looking individually at each of the seventeen sectors, we aggregate the ten manufacturing sectors and the four

[4] Presumably, some of the differences are the result of the different methodologies used to calculate indirect taxes before the adoption of VAT.

market services sectors. Only when specific characteristics emerge, will individual sectors be considered. Since we are adopting an aggregate perspective, the discussion will, in general, be based on the value added output measure to avoid double counting problems. This means that we will consider only two productive inputs: labor and capital. In any case, as we will see below, the consideration of gross production as opposed to value added (and so, intermediate consumption) reveals interesting properties, that we will stress later on.

4.1. The aggregate (market) economy

The main characteristics of our aggregate for the non-financial market economy are summarized in Table 4.1. We distinguish in our analysis between the growth rates for the total sample period (1981-1995) and for four sub-periods corresponding to the different cyclical phases experienced by the Spanish economy. For the whole sample period, the average growth rate was 2.2%, using value added as our measure of output (2.1% when gross production is used). In sharp contrast to the increase in output, over the sample period there is a reduction in labor, whether measured by total employment or hours (actually, the growth rates are –0.19% and –1.04%, respectively)[5]. This result hides interesting asymmetric cyclical behavior by the labor input. In particular, in periods when output growth is above average (economic expansions), labor tends to increase, but by a smaller amount, while in periods when output growth is below average, there is a massive decrease in employment.

A first approximation to the measurement of technological progress is labor productivity, which is defined as the ratio of output to labor. As a result of the previously described paths of output and labor, labor productivity has increased by between 2.4% and 3.3% depending on whether we use total employment or hours, respectively (when gross production is used, similar figures are obtained). The business cycle pattern of this growth is presented in the top panel of Figure 4.1. Labor productivity seems to display a counter-cyclical pattern with respect to output. This will constitute an important stylized fact for the period at hand: labor productivity tends to be higher in economic recessions, mainly as a result of massive job destruction, while it tends to be positive but low in economic expansions. The countercyclical pattern is sharper when we measure labor using hours instead of employment. Yet, on a period by period basis, there seems to be a change in the correlation between productivity and output. There are positive comovements until the end of the eighties and the beginning of the nineties, and from that period onward there is a clear countercyclical pattern.

[5] This overall reduction in labor is more significant in terms of hours because, especially during the eighties, we observe a systematic reduction in hours per head.

As can be seen in Table 4.1, the average growth rate of the capital stock (2.5%) has been higher than that of output. Moreover, the capital-labor ratio, which can be seen as a preliminary indicator of substitution between these two factors, has increased over the sample period. Again, it is the behavior of employment that makes the behavior of this ratio countercyclical. As noted above, the evolution of the cost shares incorporates useful information for understanding the dynamics of technological progress. In particular, as can be seen in Table 4.1, the labor cost share in terms of value added (the most relevant component) displays a clear downward trend until 1993, recovering slightly thereafter (note that capital costs tended to increase until the (real) interest rate began to fall). Thus, the lower this cost share is, the higher is the contribution of the capital-labor ratio to explain movements in the total factor productivity (value added-based). In terms of gross production, the most important component of costs is the intermediate consumption share, which displays a downward trend until the last sub-period. Finally, intermediate consumption shows a strong correlation with production (see panel C in Figure 4.1), although it is slightly more volatile. Taking this into consideration implies that looking at gross production not only reduces the importance of labor costs on total costs (thus making more important the contribution of the capital labor ratio) but it also modifies its profile, that now does not show any clear trend pattern.

Thus, once we properly correct value added for the changes in those components, it is not surprising that, on the light of equation (9), total factor productivity, measured using value added, displays a much lower average growth rate than labor productivity. In terms of gross production the difference is even higher, since the weight of intermediate input costs is over 50%. In the middle panel of Figure 4.1. we plot total factor productivity, in value added terms, obtained using both total employment and hours, and the growth rate of value added. It seems that the Solow residual is less volatile than labor productivity, and displays no clear cyclical pattern.

4.2. The manufacturing sector

Between 1981 and 1995 the manufacturing sector progressively declined in importance in relation to aggregate activity (both in terms of value added and gross production). At the same time, the growth rate of manufacturing output displayed higher volatility than the growth rate of the economy's total output (see Tables 4.1 and 4.2). If we use labor instead of output as a measure of the importance of the sector in the economy the results are even more dramatic. This sector has seen a systematic reduction in the level of labor (measured either using total employment or hours) except during the expansion of the late eighties. This is the main determinant of the higher level of labor productivity growth that has characterized this sector over the period 1981-1995. Again, as previously noted for the aggregate, the countercyclical pattern of this variable is apparent from Figures 4.2.A and Table 4.2.

Although the growth rate of the capital stock is also lower than for the whole economy, this sector has substituted capital for labor with a similar intensity to the economy as a whole. The labor cost share has followed a similar path that the total economy. In particular, in terms of value added, there is a reduction between 1981 and 1993, and then a recovery up to a value of 77%, slightly above the level reached by the whole economy. As a result, it is labor productivity that progressively dominates the path of total factor productivity in value added terms, which reaches positive growth over 2%. In terms of gross production, this sector has the highest intermediate cost share, although it follows a similar path to the one for the aggregate economy. However, the increase of the intermediate consumption-labor ratio has been more pronounced, showing that outsourcing has been playing an increasing role in the Spanish manufacturing sector. This high weight is the main reason for the strong correction in the growth rate of total factor productivity when we calculate it using gross production (0.64%).

From a more dissaggregated perspective (see Table 4.4), the sectors that have recorded the largest output gains within manufacturing, are Chemical Products, Machinery and Rubber and Plastics, while Textiles, Mineral Products and Other Manufacturing Products have suffered the largest declines in importance. All the sub-sectors have destroyed jobs, and the intensity of this process is loosely related to value added growth. This general destruction of manufacturing jobs is the main reason for the strong increases in labor productivity, that were most marked in Chemical Products, Transport Equipment and Machinery. At the other extreme were Paper, the Food Industry and Other Manufacturing Products. The sharp reduction in employment together with an overall increase in the capital stock (except in Chemical Products) translates into an increase in the capital-labor ratio that has reduced the growth rate of total factor productivity in terms of value added, in relation to the observed growth in labor productivity. In any case, this correction does not modify the ranking of the sectors in terms of productivity. The correction is more significant when total factor productivity is calculated in terms of gross production because the weight of intermediate consumption is quite high in all these sectors, but again there is no modification in the productivity ranking.

4.3. The non-financial market services sector

In contrast to the manufacturing sector, the services sectors display positive average growth (not only in terms of gross output but also in terms of value added) above the rate for the aggregate economy (see Table 4.3). Moreover, the path of its activity shows a high correlation with the aggregate, and much lower volatility. In addition, this group of services has behaved as the engine of employment creation in the Spanish economy. The result of these developments in output and employment lower average growth in labor productivity. In addition, the business cycle properties of this variable display a less countercyclical pattern. In fact, until the beginning of the nineties, there is a

positive correlation between labor productivity and the sectoral output growth (see the top panel of Figure 4.3).

In this sector, the increase of the capital-labor ratio seems to be smaller than at the aggregate level, with the exception of the last two years. Another important observation is that, unlike in the manufacturing sector, the most significant input in terms of gross production is labor, although its weight tends to fall progressively. However, in terms of value added, the labor share is similar to that in the manufacturing sector.

As in the case of the total economy, total factor productivity in terms of value added, displays a lower growth rate than labor productivity (and also lower than at the aggregate level), with negative or zero growth during the years 1994-1995. Again, there is no clear cyclical pattern to the path of total factor productivity over the whole sample period, but a change in the sign of this correlation is apparent around the late eighties and the beginning of the nineties. As a result of the reduced weight of intermediate consumption in total costs, there are fewer differences between total factor productivity computed using gross production and using value added. It is noticeable that this sector displays the lowest sample correlation between intermediate inputs and gross production (see the bottom panel of Figure 4.3) and the increase of the intermediate consumption-labor ratio is also smaller than at the aggregate level. This is enough to cause the duality in the total factor productivity growth rates between the manufacturing and the services sectors, that is apparent when we calculate either labor productivity or total factor productivity using value added, to vanish.

At a more dissaggregated level[6], Communications and Other Services gain in importance in terms of value added, while the weight of Transport Services and Trade and Catering decline. Apart from Transport Services, all the sectors generated employment. Labor productivity growth is positive in all the sectors and especially high in Communications (4.3%), with Other Services at the other end of the ranking. The growth rate of total factor productivity is smaller than labor productivity, because there is a general increase in the capital-labor ratio (the same being the case for the intermediate consumption-labor ratio). It is interesting to note that, even in terms of value added, the TFP growth rate in Communications is higher than the average for the manufacturing sector, and in Trade and Catering is only slightly lower. This reveals, again, that the traditional view of there being a strong duality between the technological progress in the manufacturing and services sectors is not a robust fact.

[6] Due to data limitations our dissaggregation is not very rich. A more detailed analysis of the services sectors can be found in Nuñez y Pérez (2000).

4.4. The role of the agricultural, energy and construction sectors

The main characteristic of the Agricultural sector has been its progressive loss of weight in the total economy, not only in terms of activity, but especially in terms of employment (see Table 4.4). It is not surprising, therefore, that this sector showed the highest increase in labor productivity over the sample period. Crucial has been its high rate of investment, which has allowed capital to be substituted for labor in a very intensive way. However, the incorporation of intermediate inputs to the productive process has been even higher. This modernization has made the sector highly efficienty, as shown by the fact that the growth rate of its Solow Residual has been the highest of all sectors considered in our sample (both in terms of value added and gross production).

The Energy sector has also experienced an increase in its labor productivity, mainly as a result of a constant decline in labor (both employment and hours, see Table 4.4). At the same time, the increase of the capital-labor ratio has been higher than in the aggregate market economy. Unlike in Services sector, the cost of capital in the energy sector represents a high proportion of total costs. The combination of these features has led the measure of total factor productivity to record, on average, a significant increase.

The share of the building sector in the aggregate value added was stable between 1981 and 1995, while its share in terms of employment increased (see Table 4.4). The growth rate of labor productivity was systematically below that for the total market economy (except during 1994-1995). This sector is not characterized by a high increase of the capital-labor ratio (the same being the case with intermediate consumption), and, in fact, it is the least capital intensive sector. Finally, the average growth rate of total factor productivity was slightly above the average for the total market economy (both in terms of value added and gross production).

5. The recent behavior of productivity: 1995-1999

One of the most relevant results of the Spanish economy performance in these years has been the significant fall in labor productivity growth. Using official National Accounts Statistics, the average growth rate of labor productivity from 1995 to 1999 for the whole economy was 0.7%, well below the 1.7% estimated for the previous five years[7] Although a similar path is discerned for some other European countries, such as Italy, comparison with the US economy is striking since the average rate of growth has been higher than 4.5% during that period.

Figure 4.4 reveals the size of the previously stated phenomenon. Panel A shows labor productivity growth, with the horizontal lines representing the corresponding five-year

[7] The results are similar if we include provisional information on 2000 (see, Estrada and López-Salido (2001)).

average growth rate. As can be seen, there is a substantial decline in this growth rate (not only in the average rate, but also every year), which had turned negative by the end of the sample period. The downward sloping path is more marked when total employment is used to measure the labor input, due to the increase in part-time employment (from 5% in 1994 to 6.2% in 1999) and to a slight reduction in hours worked by full-time employees. The middle panel of Figure 4.4 shows that part of the reduction in the growth rate of labor productivity was the result of a lower rate of growth in the capital-labor ratio. Although this ratio shows a clear counter-cyclical pattern, during the current expansionary period its rate of growth has been well below the previous expansionary period. The decrease in the growth rate of the capital-labor ratio is just part of the story. As can be seen in Figure 4.4.C, the growth rate of the total factor productivity in terms of value added[8] has also declined in the last five years.

The breakdown of these results between manufacturing and market services is shown in Figures 4.5 and 4.6, respectively. As can be seen in Figure 4.5, the manufacturing sector has also seen a significant deceleration in labor productivity over the last five years (panel A). This was the result of a reduction in the growth rate of the capital-labor ratio, in sharp contrast to the pattern observed during the period 1981-1995, and a much smaller deceleration in the growth rate of the Solow residual (see panels B and C). At a more disaggregated level, only three branches of activity showed an accelerating path for labor productivity. Transport Equipment, Other Industry Products and Rubber and Plastics; and the fall in labor productivity was especially marked in Steel, Chemical Products and Textiles. The capital-labor ratio fell in half of the manufacturing sectors considered, and this reduction was very significant in Steel, Minerals and Transport Equipment. The highest increases were recorded in Other Manufacturing Products, the Food Industry and Paper. Finally, only four sub-sectors saw an increase in the growth rate of their total factor productivity: Transport Equipment, Machinery, Other Manufacturing Products and Rubber and Plastics. Decreases in the Solow residual growth were apparent in Steel, Chemical Products, the Food Industry and Textiles.

Non-financial market services has also seen a deceleration in labor productivity over the last five years (see Figure 4.6.A), although smaller than the one described for the manufacturing sector. The reduction in the growth rate of labor productivity was the result of the lower –albeit positive- growth rate of the capital-labor ratio and a Solow residual that remained at the level of the previous five years (see Figure 4.6. panels B and C). At a more disaggregated level, two branches have seen increases in labor productivity with respect to the previous five years (Trade and Catering and Transport services). In the other two sub-sectors (Communications and Other Services) labor productivity fell. In both cases this reduction was the result of a very strong growth rate of employment, especially

[8] When using gross production the conclusions are not modified.

in 1998 and 1999. The capital-labor ratio has only decreased in one sector (Trade and Catering), and its growth rate has increased in the other two: Transport services and, especially, Communications. As a result, only one sector has recorded significant increases in the growth rate of technological progress: Trade and Catering.

6. Conclusions

The correct measurement of the technological progress in an economy is crucial for characterizing both its short and long run dynamic performance. Usually, technological progress is identified with labor productivity, but this is influenced by the relative utilization of the different productive factors. For example, in the last two decades in Spain there has been a progressive increase of the capital-labor ratio leading to an over-estimation of technological progress when using labor productivity. One way to correct for this effect is to calculate the so-called Solow residual.

During the period 1981-1995 labor productivity increased by 3.3%, while, after adjusting for the growth of labor costs and the changes in the capital-labor ratio, total factor productivity growth, in terms of value added, was 2.5%. From a cyclical perspective, the labor productivity is influenced by changes in employment. In particular, during downturns, the reduction in employment is translated into an above-average increase in productivity, while in upturns productivity growth falls below the average. At this aggregate level, the relevant measure of activity is value added, as opposed to gross production, which includes intermediate inputs. This is due to the double counting problem that appears when aggregating intermediate consumption that has been produced for other firms. However, at a lower level of aggregation gross production is more relevant. Considering both measures of activity reveals a very interesting phenomenon: while in terms of value added, total factor productivity in the manufacturing sector is much higher than in services (2.4% and 1.1% respectively), in terms of gross production they are virtually the same (0.6% and 0.7% respectively). During the latest cyclical expansion of the Spanish economy we have observed a marked deceleration in labor productivity, associated to an increase in employment. In spite of this, the growth rate of total factor productivity has diminished by a smaller amount, because the capital-labor ratio has grown more slowly. At a sectoral level, the deceleration of labor productivity was higher in the manufacturing sectors than in services, although in both cases the growth rate of total factor productivity remained at the same levels as in the first half of the nineties.

Table 3.1. Sectoral Coverage

Sector Code	Sectors	NACE, Rev 1 Code
A	Agricultural, Forestry and Fishery	A, B
E	Fuel and Power Products	C, DF, E
M1	Ferric and Non-Ferric Industries plus Metals[9]	DJ
M2	Non Metallic Minerals and Mineral Products	DI
M3	Chemical Products	DG
M4	Machinery[10]	DK, DL
M5	Transport Equipment	DM
M6	Food, Beverages and Tobacco	DA
M7	Textiles and Clothing, Leather and Footwear	DB, DC
M8	Other Manufacturing Products	DD, DN
M9	Paper and Printing Products	DE
M10	Rubber and Plastic Products	DH
C	Building and Constructions	F
S1	Repair Services, Wholesale and Retail Services[11]	G, H
S2	Inland Transport, Maritime and Air Services[12]	I60, I61, I62, I63
S3	Communication Services	I64
S4	Other Market Services	K, M, N, O

[9] Metal products except machinery and transport equipment.

[10] Including Office and Data Processing Machines, Precision and Optical Instruments, and Electrical Goods.

[11] Including Accommodation and Catering Services

[12] Including Auxiliary Transport Services

TABLE 4.1. DESCRIPTIVE STATISTICS. NON-FINANCIAL MARKET ECONOMY. Growth rates

	1981-1995	1981-1985	1986-1991	1992-1993	1994-1995
Output indicators					
Production	2.13	0.75	4.04	−0.72	2.74
Value Added	2.22	0.44	4.49	0.17	1.89
Productive Inputs					
Intermediate Inputs	2.05	1.03	3.81	−1.61	3.59
Employment	−0.19	−2.45	2.40	−3.13	0.67
Hours	*−1.04*	*−4.09*	*1.77*	*−3.25*	*0.34*
Capital Stock	2.45	1.29	3.59	2.32	2.06
Labor Productivity					
Production Based					
Per Person	2.32	3.20	1.64	2.41	2.07
Per Hour	*3.18*	*4.83*	*2.27*	*2.52*	*2.41*
Value Added Based					
Per Person	2.40	2.90	2.09	3.30	1.22
Per Hour	*3.26*	*4.53*	*2.72*	*3.41*	*1.56*
Productive Input Ratios					
Intermediate Cons.–Labor Ratio	2.24	3.49	1.21	1.52	2.92
Per Hour	*3.10*	*5.12*	*1.84*	*1.64*	*3.26*
Capital–Labor Ratio	2.64	3.74	1.19	5.45	1.39
Per Hour	*3.49*	*5.37*	*1.82*	*5.57*	*1.73*
Cost Shares					
Production Based					
Intermediate Cost Share	56.69	60.73	55.64	52.02	54.37
Labor Cost Share	32.29	32.04	31.53	33.65	33.82
Capital Cost Share	11.02	7.23	12.82	14.33	11.81
Value Added Based					
Labor Cost Share	74.89	81.61	71.14	70.13	74.12
Capital Cost Share	25.11	18.39	28.86	29.87	25.88
Total Factor Productivity					
Production Based					
Per Person	0.77	0.83	0.84	0.83	0.34
Per Hour	*1.04*	*1.35*	*1.04*	*0.87*	*0.45*
Value Added Based					
Per Person	1.78	2.25	1.73	1.67	0.86
Per Hour	*2.45*	*3.58*	*2.18*	*1.75*	*1.11*

TABLE 4.2. DESCRIPTIVE STATISTICS. MANUFACTURING SECTOR. Growth rates					
	1981-1995	1981-1985	1986-1991	1992-1993	1994-1995
Output indicators					
Production	1.77	0.02	3.63	-2.01	4.36
Value Added	1.35	-0.91	3.50	-2.15	4.01
Productive Inputs					
Intermediate Inputs	1.97	0.46	3.69	-1.95	4.51
Employment	-1.15	-3.90	1.96	-4.43	-0.29
Hours	*-1.70*	*-5.16*	*1.60*	*-4.94*	*0.33*
Capital Stock	1.40	-1.14	3.81	1.62	0.27
Labor Productivity					
Production Based					
Per Person	2.92	3.93	1.67	2.42	4.65
Per Hour	*3.47*	*5.19*	*2.04*	*2.93*	*4.03*
Value Added Based					
Per Person	2.49	3.00	1.54	2.28	4.30
Per Hour	*3.04*	*4.26*	*1.91*	2.79	*3.68*
Productive Input Ratios					
Intermediate Cons.-Labor Ratio	3.12	4.36	1.73	2.48	4.80
Per Hour	*3.67*	*5.62*	*2.10*	*2.99*	*4.18*
Capital-Labor Ratio	2.54	2.77	1.85	6.05	0.56
Per Hour	*3.10*	*4.03*	*2.21*	*6.56*	*-0.06*
Cost Shares					
Production Based					
Intermediate Cost Share	71.90	74.26	71.60	68.07	70.70
Labor Cost Share	21.97	22.03	21.27	23.39	22.48
Capital Cost Share	6.14	3.71	7.13	8.54	6.82
Value Added Based					
Labor Cost Share	78.50	85.55	74.97	73.25	76.72
Capital Cost Share	21.50	14.45	25.03	26.75	23.28
Total Factor Productivity					
Production Based					
Per Person	0.52	0.59	0.32	0.21	1.26
Per Hour	*0.64*	*0.87*	*0.40*	*0.33*	*1.12*
Value Added Based					
Per Person	1.94	2.62	1.05	0.67	4.17
Per Hour	*2.39*	*3.71*	*1.32*	*1.04*	*3.69*

TABLE 4.3. DESCRIPTIVE STATISTICS. NON-FINANCIAL MARKET SERVICES SECTOR. Growth rates

	1981-1995	1981-1985	1986-1991	1992-1993	1994-1995
Output Indicators					
Production	2.86	2.32	4.09	1.10	2.28
Value Added	2.69	1.18	4.64	1.29	2.03
Productive Inputs					
Intermediate Inputs	3.24	4.75	2.97	0.70	2.80
Employment	1.83	–0.29	4.26	–0.46	2.11
Hours	*0.88*	*–2.16*	*3.78*	*–0.70*	*1.32*
Capital Stock	3.63	1.85	5.00	3.64	3.73
Labor Productivity					
Production Based					
Per Person	1.04	2.62	–0.16	1.56	0.16
Per Hour	*1.99*	*4.49*	*0.31*	*1.81*	*0.96*
Value Added Based					
Per Person	0.87	1.47	0.38	1.75	–0.08
Per Hour	*1.82*	*3.35*	*0.86*	*1.99*	*0.71*
Productive Inputs Ratios					
Intermediate Cons.–Labor Ratio	1.41	5.04	–1.29	1.16	0.69
Per Hour	*2.36*	*6.91*	*–0.82*	*1.41*	*1.48*
Capital–Labor Ratio	1.80	2.14	0.74	4.30	1.62
Per Hour	*2.75*	*4.01*	*1.21*	*4.55*	*2.41*
Cost Shares					
Production Based					
Intermediate Cost Share	35.51	36.79	35.06	33.58	35.57
Labor Cost Share	47.86	50.53	46.35	46.21	47.40
Capital Cost Share	16.63	12.68	18.60	20.21	17.03
Value Added Based					
Labor Cost Share	74.28	79.91	71.40	69.57	73.57
Capital Cost Share	25.72	20.09	28.60	30.43	26.43
Total Factor Productivity					
Production Based					
Per Person	0.21	0.49	0.14	0.30	–0.36
Per Hour	*0.68*	*1.43*	*0.36*	*0.41*	*0.02*
Value Added Based					
Per Person	0.40	1.05	0.15	0.43	–0.51
Per Hour	*1.13*	*2.54*	*0.48*	*0.61*	*0.08*

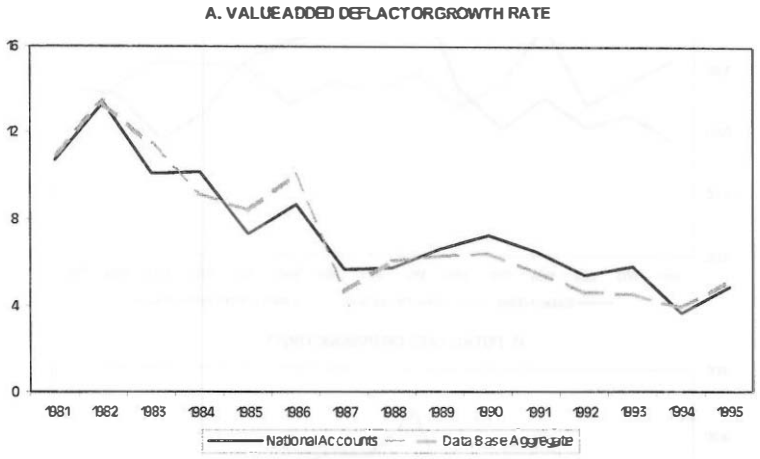
TABLE 4.4. FULL-PERIOD SECTORAL AVERAGES. Growth rates

	Output Indicators		Input Indicators			Labor Productivity		Total Factor Productivity	
	Gross Production	Value Added	Intemediate	Labor*	Capital	Gross Production*	Value Added*	Gross Production*	Value Added*
A	0.99	0.85	1.18	-5.44	0.33	6.43	6.29	2.39	4.59
E	0.96	2.79	-0.46	-2.44	1.11	3.40	5.23	1.74	3.27
M1	-0.49	0.70	-0.99	-1.49	0.06	1.01	2.19	0.49	1.84
M2	1.02	0.32	1.58	-2.74	1.79	3.76	3.06	0.73	1.94
M3	3.55	3.66	4.14	-1.62	-0.31	5.17	5.28	1.32	4.88
M4	3.87	3.06	4.39	-0.79	2.43	4.66	3.85	1.19	3.37
M5	2.92	1.64	3.42	-2.22	2.02	5.14	3.87	0.85	2.94
M6	1.58	1.09	1.74	-0.85	1.93	2.43	1.93	0.19	1.29
M7	0.20	-0.62	0.59	-3.37	0.24	3.57	2.75	0.58	2.22
M8	1.10	0.42	1.50	-1.96	2.39	3.07	2.38	0.59	1.80
M9	2.29	1.28	2.89	-0.09	3.68	2.38	1.37	0.16	0.59
M10	4.09	2.67	5.07	-0.36	2.58	4.45	3.03	0.64	2.30
C	1.91	2.30	1.68	-0.36	1.13	2.27	2.65	0.85	2.58
S1	2.57	2.22	3.41	0.43	2.28	2.15	1.79	0.87	1.71
S2	1.41	1.06	1.97	-1.33	2.25	2.74	2.39	0.65	0.94
S3	5.40	5.61	4.66	1.30	3.74	4.10	4.30	2.27	2.99
S4	3.90	4.01	3.66	2.95	4.10	0.95	1.06	0.35	0.65

* Calculated over total hours.

Figure 3.1. Comparison with National Accounts aggregates.
Variables in real terms

Figure 3.2. Comparison with National Accounts aggregates.
Prices



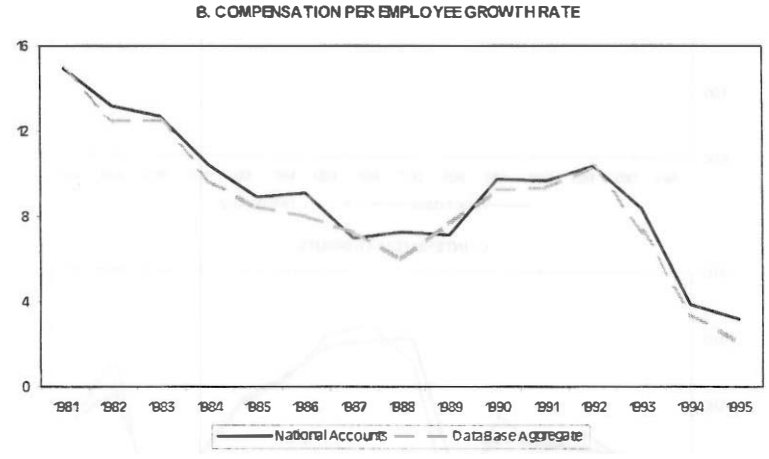


Figure 4.1. Non-financial market economy. Growth rates

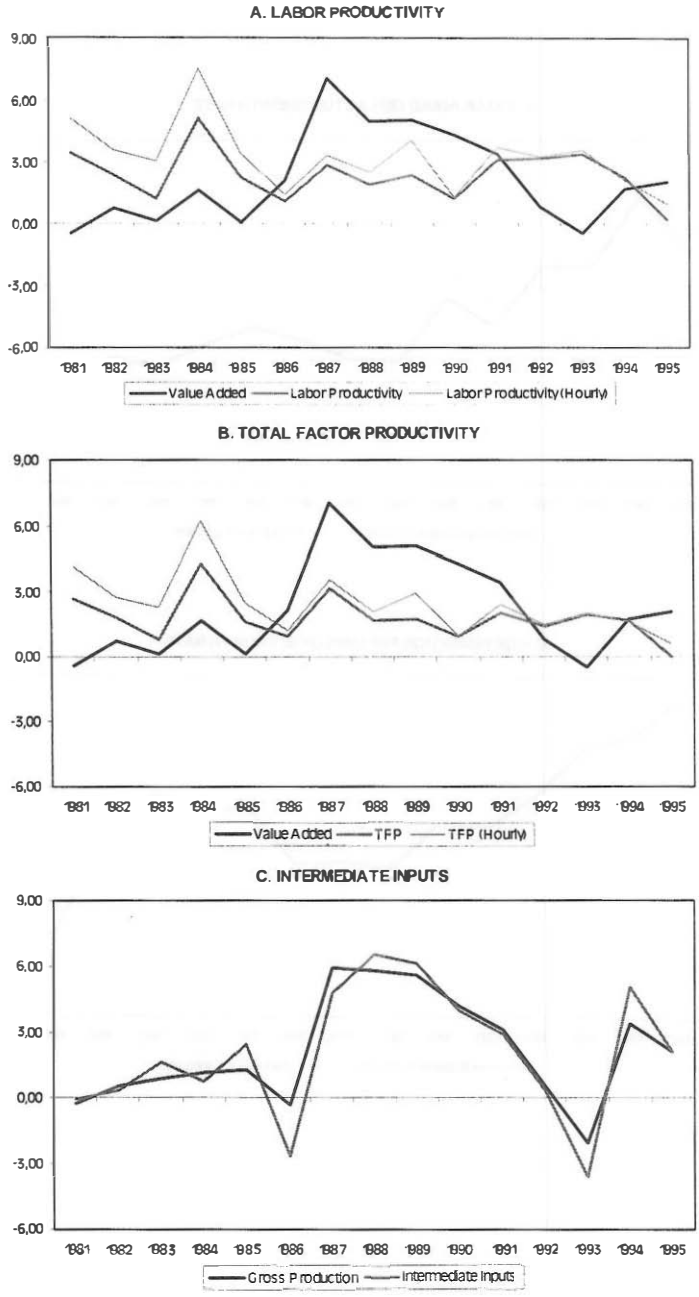


Figure 4.2. Manufacturing sector. Growth rates

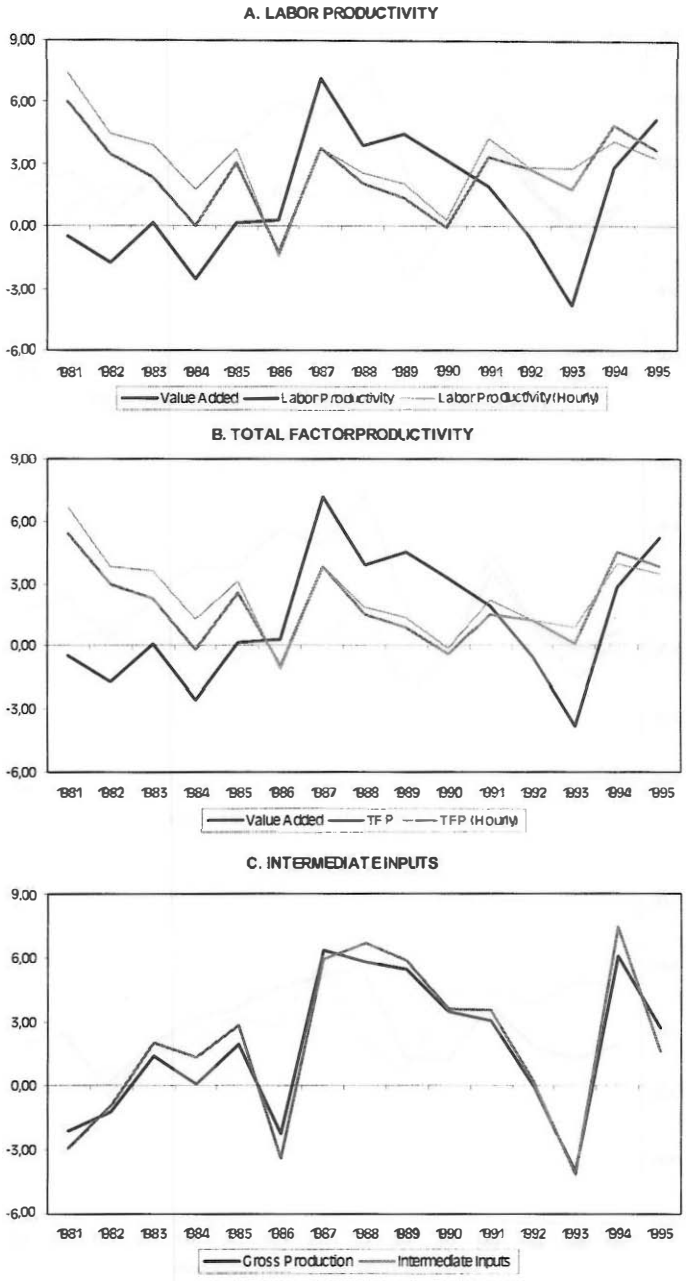


Figure 4.3. Non-financial market services sector. Growth rates

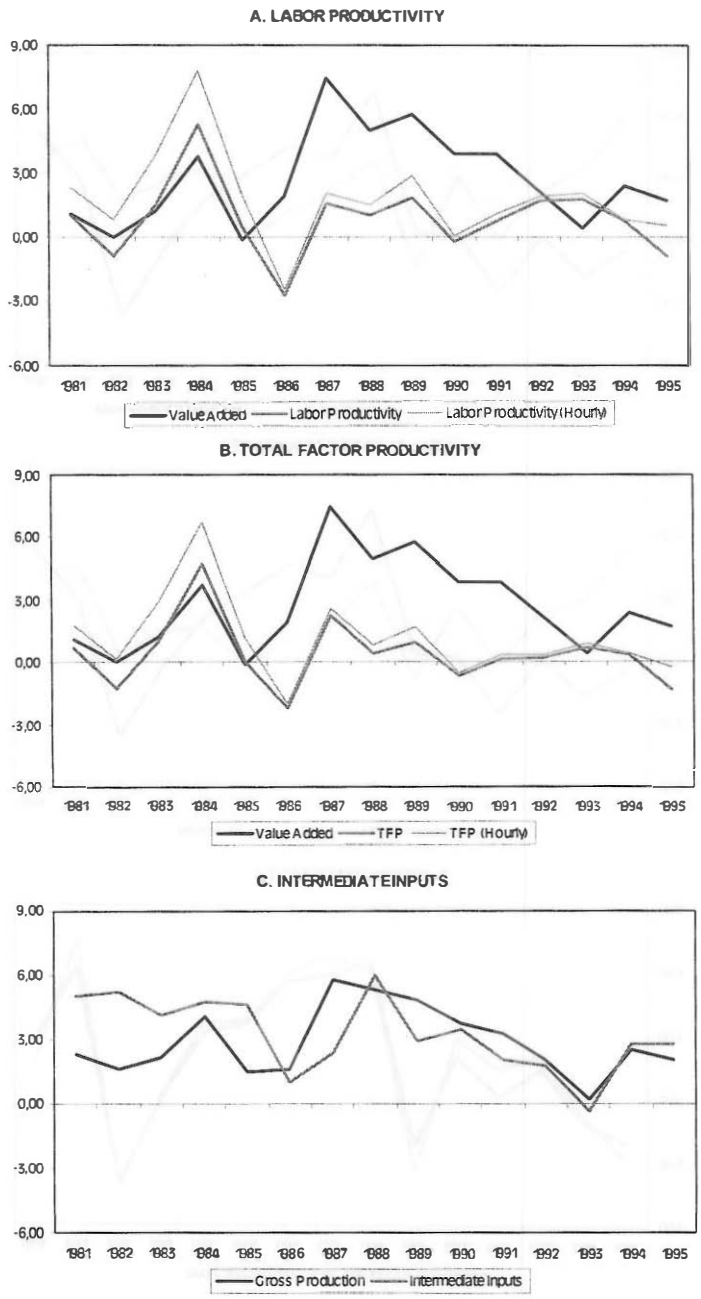
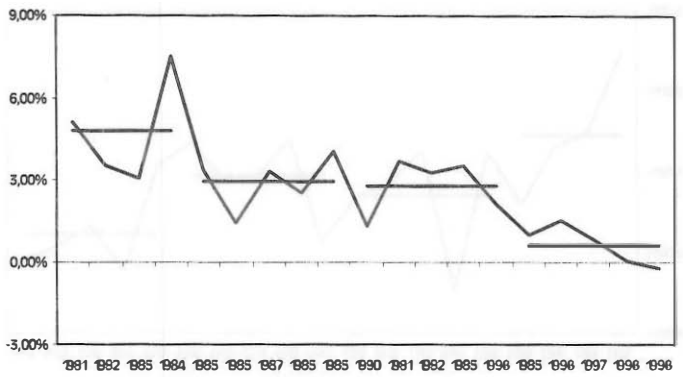
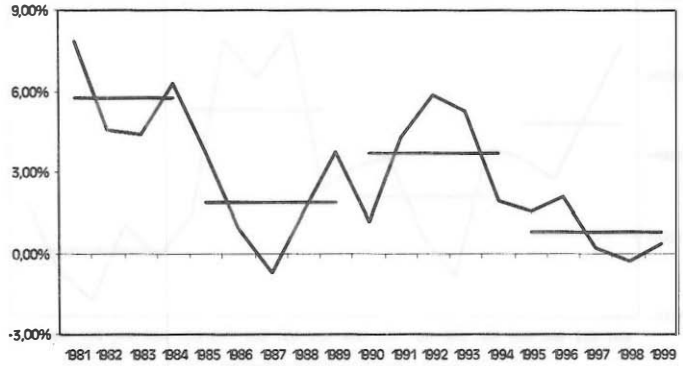


Figure 4.4. Extending the data-base. Non-financial market economy.

A. LABOR PRODUCTIVITY



B. CAPITAL LABOR RATIO



C. TOTAL FACTOR PRODUCTIVITY

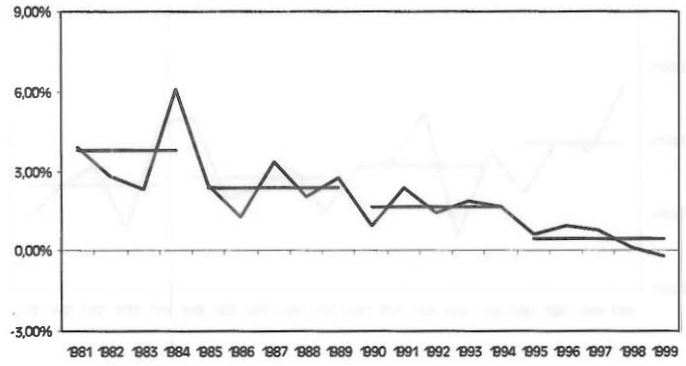


Figure 4.5. Extending the data-base. Manufacturing sector.

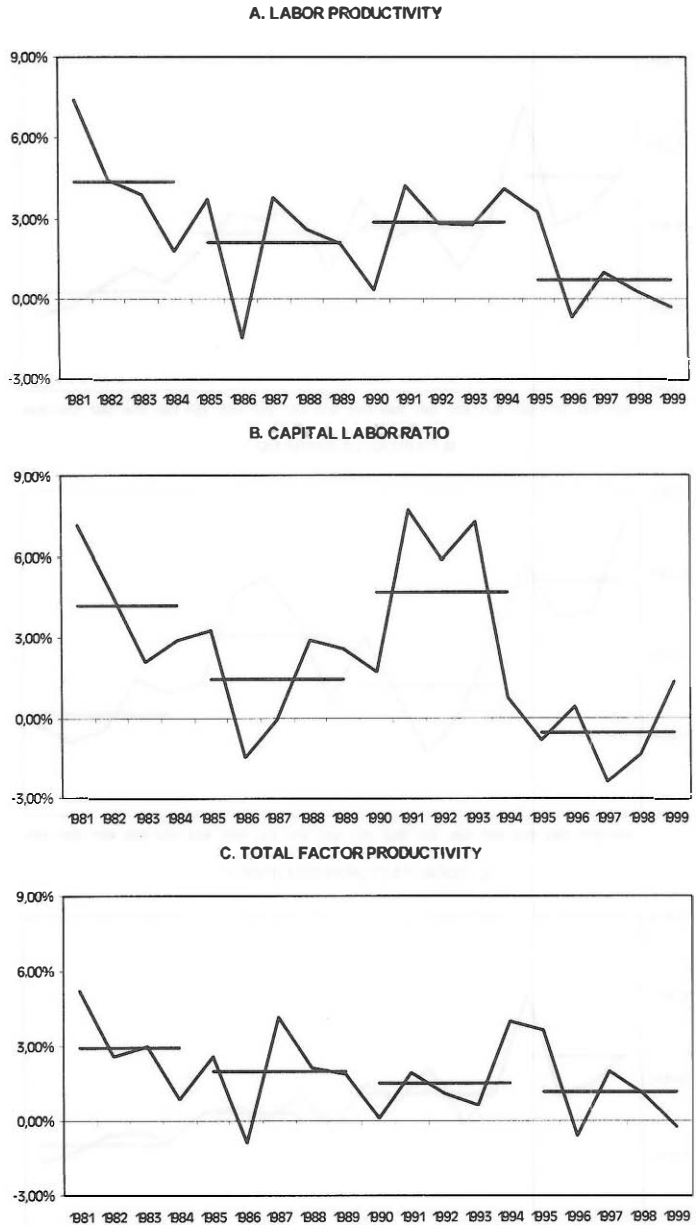
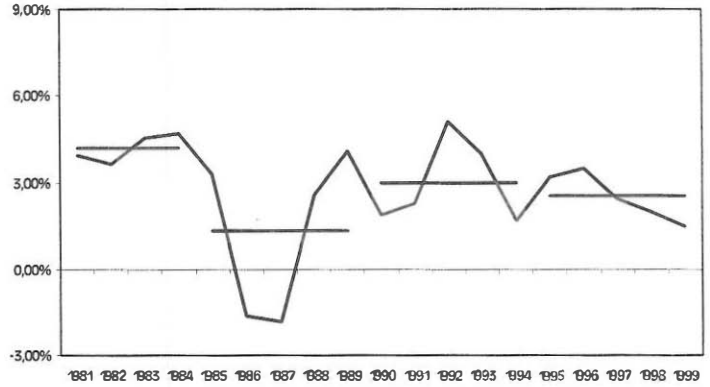


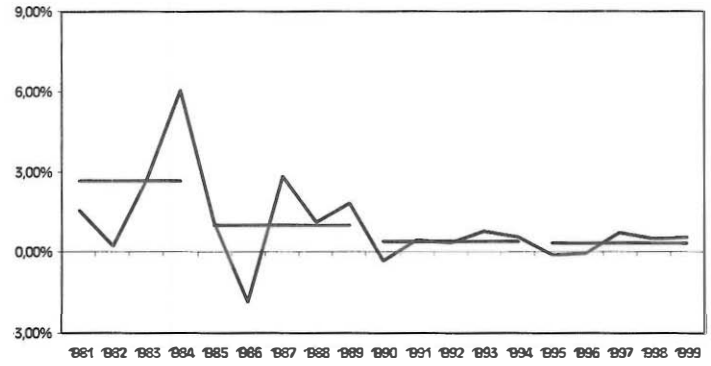
Figure 4.6. Extending the data-base. Non-financial market services sector.

A. LABOR PRODUCTIVITY

B. CAPITAL LABOR RATIO



C. TOTAL FACTOR PRODUCTIVITY



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