INSTITUTO UNIVERSITARIO
de Análisis Económico y Social

Universidad de Alcalá

www.iaes.es

Recent cyclical movements in the spanish productivity. An aggregate and sectoral analysis

Andrés Maroto-Sánchez y Juan R. Cuadrado-Roura

SERIE DOCUMENTOS DE TRABAJO
06/2013

RECENT CYCLICAL MOVEMENTS IN THE SPANISH PRODUCTIVITY. AN AGGREGATE AND SECTORAL ANALYSIS

RESUMEN

Uno de los temas más debatidos en la economía española es el de su productividad. Mientras en la época expansiva se observó un comportamiento negativo de esta variable, en los últimos años de fuerte crisis económico-financiera su evolución ha sido mucho más positiva, al contrario de lo observado en otros países de nuestro entorno. Por esta razón, el presente trabajo trata de analizar el efecto del ciclo económico sobre nuestra productividad desde los años 80s hasta la presente crisis, usando datos de la Contabilidad Nacional Trimestral (INE) y The Conference Board, prestando particular atención en la peculiar estructura sectorial de nuestra economía.

Palabras clave: Productividad, Ciclo económico, Filtro HP, Estructura productiva.

ABSTRACT

One of the most debated themes on the Spanish economy is the one related to productivity. While negative trends were observed during the time of expansion, its evolution has become much more positive during the recent years of strong economic and financial crisis. Additionally, this behaviour is contrary to that displayed by other European countries. For this reason, this paper aims to analyse the effects of the economic cycle on Spanish labour productivity from 1980 onwards, especially focusing on the characteristic industrial structure of our economy. We use data provided by the Conference Board and the Quarterly National Accounts (INE).

Key words: Productivity, Business Cycle, HP Filter, Productive structure.

AUTOR

ANDRÉS MAROTO SÁNCHEZ Senior Lecturer in the Department of Economic Analysis: Economic Theory, Universidad Autónoma de Madrid. Researcher in the Instituto de Análisis Económico y Social (IAES), Universidad de Alcalá, Madrid.

JUAN RAMÓN CUADRADO ROURA Professor in Applied Economics. Director-Founder of the Instituto de Análisis Económico y Social (IAES), Universidad de Alcalá, Madrid.

ÍNDEX

1. INTRODUCTION: OBJETIVES AND APPROACH

The positive evolution of productivity is a key factor in the development of any economy and the improvement of its citizens' welfare. In the long term, in order for any country to reach sustained economic growth, this should be accompanied by continuous improvements in productivity. In fact, growth and productivity are two sides of the same coin. Any country aiming at increasing average per capita income should either produce more goods and services with the same number of workers – through technological, organisational and capital equipment improvements – or increase the number of people available for work or make the productive system create jobs for the unemployed. However, achieving continuous productivity growth is not easy, not least because it depends on a vast array of factors among which are some whose influence is considered vital: the accumulation of capital, technological advances and improvements in terms of efficiency in the use and combination of factors, which is generally identified by the so-called 'total factor productivity'.

When analysing the evolution of productivity in economies, we can observe that the *cyclical fluctuations* experienced by them can and often do affect this variable. In fact, there have been various studies in the economic literature for many years confirming that the improvement or negative performance of this variable could be due to such cyclical fluctuations rather than to the fact that the economy in question has increased the aforementioned basic factors (labour, capital and technology) or reached a higher level of efficiency in the use of these factors (Basu and Fernald, 2000).

The Spanish economy seems to be a good example of this latter statement. Aggregate data shows that the current economic crisis has brought about an outstanding improvement in labour productivity, in contrast with the low levels registered by this variable between 1995 and 2007[1]. This period was characterised precisely by the achievement of high growth rates and an employment creation capacity that seemed

[1] During this period (1995-2006/07), the productivity of American economy registered strongly positive gains which, with limited exceptions, were always above the majority of the EU economies both in terms of productivity per worker and multi-factor productivity (Maroto and Cuadrado, 2006; Cuadrado and Maroto, 2012; O'Mahony and Van Ark, 2003; BBVA, 2010, among others). Throughout this long period of expansion, the Spanish labour productivity was clearly below the EU-15 average and obviously also far below American economic rates. Moreover, the Spanish multi-factor productivity, which informs about improvements in efficiency regarding the use and organisation of factors, was virtually zero and even negative, on average, in some of the years of the period under analysis.

to be enviable. Nevertheless, this does not match up with what has happened in the majority of advanced countries[2]. The best explanation for this could possibly be found in some of the past and present features of the Spanish economic crisis, more specifically the sharp and fast fall in employment and the specialisation of Spanish economy in activities markedly influenced by the cyclical component, such as construction and certain end-consumer services.

The main objective of this article is to delve into the behaviour of Spanish productivity from the perspective of cyclical shifts. To this purpose, the starting point is a brief presentation of the differences arising when comparing the behaviour of GDP variation rate, employment and productivity in the EU-25 countries (section 2), including Spain. Then, after providing the basic description of the methodology used, we present the results obtained when exploring the relationship between labour productivity and the cycle in Spain at an aggregate level (section 3). Afterwards, we provide the results obtained from analysing the evolution of productivity on a sectoral basis, where we also go into the coherence and cyclical synchrony of the referred sectoral productivity, as well as into its volatility, in more depth. Finally, the main conclusions of the analysis are briefly summed up.

The data used in this analysis comes from the database created by The Conference Board (Total Economy Database, 2012), which allows us to deal reliably with the international comparisons presented in section 2, and the figures of the *Contabilidad Nacional Trimestral* (Quarterly National Accounts), prepared by the INE (Spanish Employment Institute) (2012), which have been used to develop the productivity-cycle empirical analyses in the Spanish case.

2. THE CRISIS AND ITS IMPACT ON THE PRODUCTIVITY OF THE EU-25

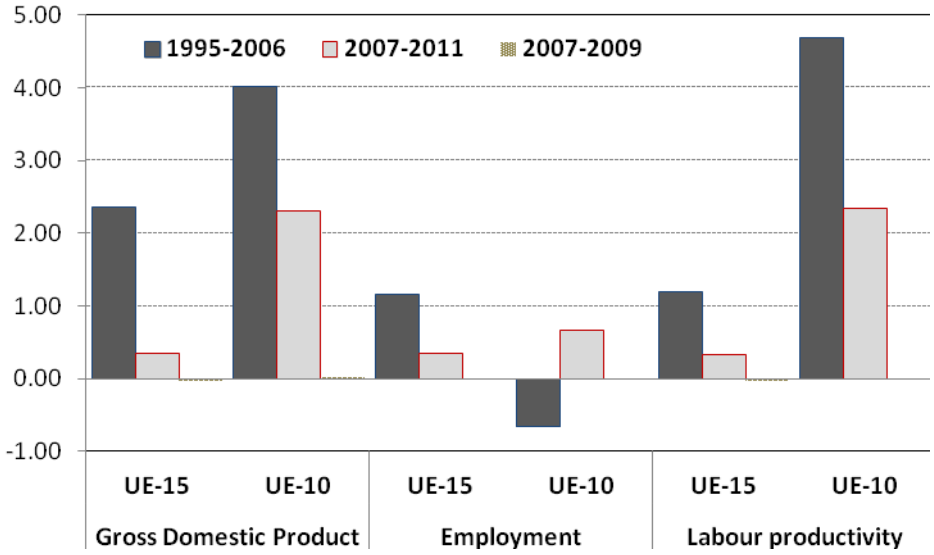
The sharp economic-financial crisis that broke out in 2007 has hit the majority of countries in the European Union hard, although with varying levels of intensity. Globally speaking, particularly between 2007 and 2009, the result of this impact has been a slowdown of labour and multi-factor productivity growth rate. The consequence of this was a fall in production, labour shedding and probably also the deceleration of other factors such as the quality of the workforce and the use of technological capital.

However, the behaviour of some countries does not correspond to this general trend, Spain being among them. This country registered positive productivity growth rates during the period 2007-2011, therefore being

2 A consensus have been reached in both theoretical and empirical works regarding productivity growth, where just a few researchers question whether aggregate productivity is pro-cyclical.

virtually the only European country where productivity growth accelerated compared to the period 1995-2006. The main reason for this improvement has been the strong labour shedding in the country since the beginning of the crisis, only exceeded by Ireland and some Baltic countries such as Estonia and Latvia until 2010, although the general figures reached by these countries are much lower than those of Spain.

Figure 1
Impact of the crisis on production, employment and productivity in the European Union (eu-10 vs eu-15)



Source: Prepared by the authors, based on TCB data (2012)

Figure 1 clearly shows that the effect of the crisis within the EU has not been homogeneous. The new Member States (EU-10) registered higher productivity growth rates between 2007 and 2011 because, despite the sharp fall in their gross production, the growth rates of this variable are still far above the western European countries. This relates to the fact that, as a consequence of lower job-creation rates in the EU-10 already since the mid-1990s, the impact of the crisis has not affected their productivity to the same extent as in the majority of the EU-15 countries. This has resulted in a statistical effect that has been translated into higher and always positive productivity growth rates (4.7 per cent between 1995 and 2006, and 2.3 per cent between 2007 and 2011, against 1.2 per cent and 0.3 percent respectively for the EU-15). As aforementioned, the results corresponding to the period 2007-2009 were clearly worse throughout Europe, with virtually zero annual average rates in both areas under analysis.

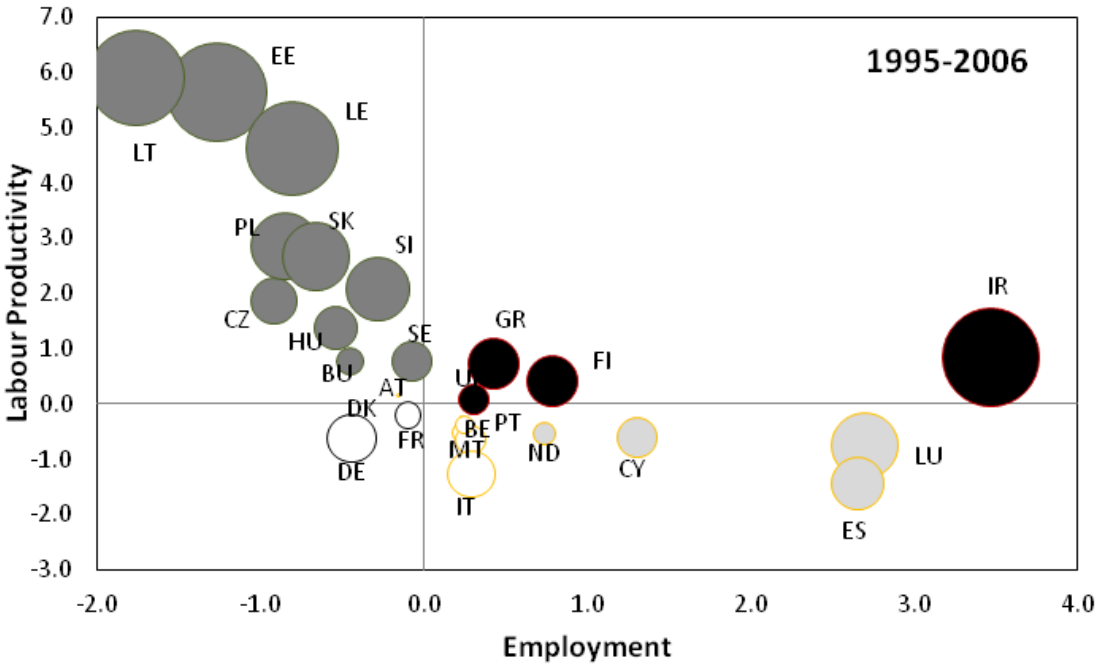
Figure 2 provides a better understanding of the heterogeneous behaviours within the EU. On the basis of the methodology introduced by Camagni and Cappellin in 1985, which we have already used in

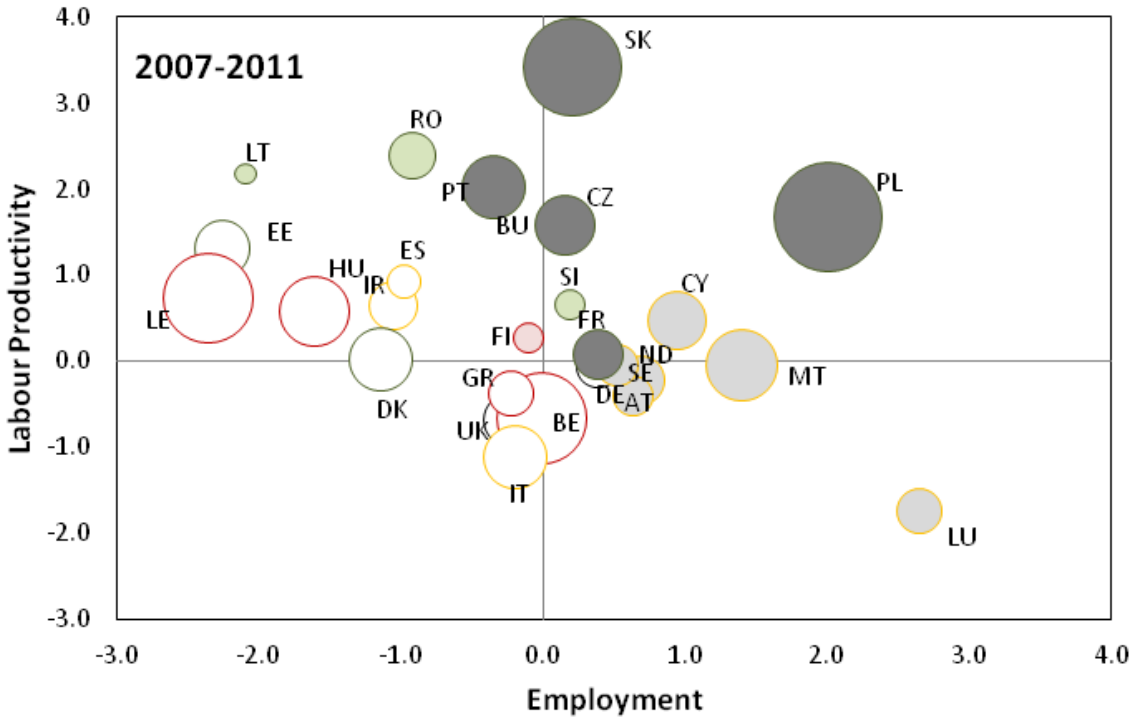
previous works on productivity (Maroto and Cuadrado, 2009), we can see which were the more dynamic countries before the crisis and their respective evolutions from 2007 onwards. This methodology differentiates between *dynamic* countries (first quadrant), *restructuring* countries (second quadrant), *backward* countries (third quadrant) and *labour-intensive* countries (fourth quadrant).

More specifically, the most dynamic European countries during the period before the crisis (1995-2006) were Ireland, Greece, the United Kingdom, Finland and Latvia (in black), with employment and productivity growth rates above the European average. On the contrary, countries such as Germany and Denmark (in white) registered lower growth rates than the European average both in terms of employment and productivity. The rest of the European countries displayed either good productivity results thanks to strong labour shedding (in dark grey)—such as Sweden or the majority of eastern European countries—or bad results regarding productivity due to being labour-intensive—as in the Spanish case (in light grey).

Nevertheless, this panorama changed dramatically after the start of the economic-financial crisis. As shown in the 2007-2011 chart below, most of the countries previously included in the upper quadrants (registering good productivity results) are now found in the lower quadrants.

Figure 2
Production, employment and productivity in Europe (1995-2006) and impact of the crisis (2007-2011)





NOTE 1: X axis: difference between employment growth in each country and the European average (UE-25); Y axis: difference between productivity growth in each country and the European average; Size of the bubble: difference between the production growth (added value) in each country and the European average.

NOTE 2: AT: Austria; BE: Belgium; BU: Bulgaria; CY: Cyprus; CZ: Czech Republic; DE: Germany; DK: Denmark; EE: Estonia; ES: Spain; FI: Finland; FR: France; GR: Greece; HU: Hungary; IR: Ireland; IT: Italy; LE: Latvia; LT: Lithuania; LU: Luxembourg; MT: Malta; ND: Holland; PO: Poland; PT: Portugal; RO: Romania; SI: Slovenia; SK: Slovakia; SE: Sweden; UK: United Kingdom.

NOTE 3: Typology of countries: dynamic countries in black (employment and productivity above the average); backward countries in white (employment and productivity below the average); restructuring countries in dark grey (productivity above and employment below the average); and labour-intensive countries in light grey (productivity below and employment above the average)

Source: Prepared by the authors, based on TCB data (2012)

Only some eastern European countries such as Poland, the Czech Republic, Slovakia and Cyprus, and also France and Holland to a lesser extent, behave dynamically. On the other side, a good number of countries, including Italy, Denmark, Slovenia, Estonia or Hungary, were in decline. Even more significant are the cases of Latvia, Greece and Finland, which went from being dynamic to being in decline in the wake of the crisis.

The Spanish case, which we will analyse in more detail in the next section, shows a particularly interesting change. Between 2007 and 2011, Spain reached a position among those countries registering the highest productivity growths, together with Bulgaria and Slovakia. As

aforementioned, this was only due to the sharp labour shedding process in the Spanish economy since 2007, as the gross production growth in this country was below the European average and the productive capital accumulation maintained at very low levels.

3. THE CYCLICAL PERFORMANCE OF PRODUCTIVITY IN SPAIN

As mentioned in the previous section, the crisis has been quite different in Spain compared to other European countries[3]. In the Spanish case, two crises have clearly overlapped: the financial one and the crisis linked to the collapse in housing construction, which has dragged down a number of industries linked to this sector (Cuadrado et al., 2010). The impact caused by the so-called 'housing bubble' largely explains the drop in employment, to which the decline in family consumption and, more recently, the State, regional and local expenditure and investment restraint, have also contributed.

Regarding the performance of productivity in Spain, we can clearly observe that it has a marked influence from the economic cycle, as its evolution during the last expansive and recessive cycles has been notably different. However, the question arises whether the relationship between cycles and productivity has followed the patterns of the rest of the neighbouring economies, and if this is not the case, the reason behind it. In the previous section of this chapter, we stated that productivity had a pro-cyclical performance in the majority of cases. Why does this not occur in Spain, at least in recent years?

The intended objective of this section is twofold. On the one hand, we will try to demonstrate through statistical techniques that the behaviour of Spanish productivity (labour productivity[4]) is not only related to the economic cycle, but this relationship is significantly negative. On the other hand, we will try to give some possible answers to why this occurs, principally from the viewpoint of the Spanish economic structure and the performance of sectoral productivities, which will be analysed in section 4.

3.1. Methodological aspects

Before linking productivity to the economic cycle, we need to clarify cyclical fluctuations. To this end, we will break down economic growth

[3] For a more detailed analysis of the recent evolution of productivity in our country, see Cuadrado and Maroto (2012).

[4] Only labour productivity will be taken into consideration for this analysis, because we would need highly-detailed quarterly data in order to be able to examine properly the performance of MFP in the Spanish economy, and this information does not exist so far in referring to some of the variables whose inclusion should be mandatory.

(approximated using national GDP growth) and variations of labour productivity both as regards to their trend and their cyclical component. An economic cycle has been traditionally defined as the sequence of expansion and contraction phases of economic activity. In other words, from the classical perspective, recession and expansion have been approximated by the negative or positive sign of the economic activity. However, those slowdown phases in which economic growth rates decrease despite remaining positive are also included within the term '*economic cycle*' in recent decades. As we focus on the cyclical behaviour of productivity in this work, we will adopt this latter, broader concept.

When analysing cyclical fluctuations, we need to estimate in the productivity series the underlying trend in each series analysed – productivity in this case – in order to establish the structural or long-term component of the short-term or cyclical deviations. There are various methods to accomplish this task. Zarnowitz and Ozyldirim (2001) compared and contrasted some of these methods and came to the conclusion that very similar results were obtained with them. The filter introduced by Hodrick and Prescott in 1997 (hereinafter 'HP') is one of the methods by which a correct decomposition of the trend and the cyclical fluctuation is obtained, and we will use this one here.

This filter[5] is based on the original definition by Lucas (1977) of the cyclical component of a variable (as those deviations of the smoothed trend of such a variable) and estimates a trend component minimising the deviation of this trend. This is an optimisation problem subject to restrictions where the restriction is the smoothing parameter, generally known as λ. The formal expression of the problem is the following:

$$\min\left\{\sum_{t=1}^{N}(Y_t - T_t)^2 + \lambda\sum_{t=k+1}^{N}(\nabla^k T_t)^2\right\},$$

where Y_t represents the value of the original series, T_t is the trend and $\nabla T_t = T^t - T^{t-1}$, $\nabla^k = \nabla(\nabla^{k-1})$ is the lag operator for a specific λ parameter.

The first component of the previous equation approximates the goodness of fit in the minimisation, while the second one measures the level of smoothness, affecting the slowing downs in the growth of the trend component negatively. The variations in the λ parameter alter the balance between both components of the equation. The formulation presented shows that, if *lambda* tends to zero, the cyclical deviations are minimised without restrictions, so the trend would be equal to the original series. Likewise, if the parameter tends to infinite, the trend converges to a linear series.

[5] See King and Rebelo (1993), and Blackburn and Ravn (1991) for a more detailed analysis of the filter.

The main reason to opt for the HP filter[6] was that this was the method used in various recent works regarding the cyclical behaviour of productivity. Therefore, it is a correct way to compare our results with those obtained in such works, e.g. Inklaar and McGuckin (2003), Maroto and Rubalcaba (2008) for the European Union countries, Gordon (2003) for the United States, and Cuadrado and Ortiz (2001), and Maroto (2011) for Spain. Another advantage of this filter is that it offers estimates even for the end of the sample. Although these estimates are less robust than those for intermediate periods[7], they are the most interesting ones for us because they explain the cyclical behaviour in the period of economic-financial crisis.

The implementation of any trend filter requires the determination of the value of the *lambda* parameter. Hodrick and Prescott (1997) suggested in their seminal work that this parameter should be equal to 1,600 for quarterly data. On the other hand, Ravn and Uhlig (2002) suggest a simple formula to find the parameter for different data frequencies. Since frequency is quarterly in this case, the *lambda* parameter by Ravn-Uhlig coincides with that by Hodrick-Prescott and therefore it will be equal to 1,600.

Despite the advantages outlined so far, the statistical properties of filtered or non-trend components still are a matter of debate[8]. For this reason, we will further analyse the sensitivity of our estimates through the calculation of volatility and cyclical synchrony measures. Therefore, the standard deviation of the filtered series is used as an approximation of the volatility of the cyclical component in relative terms. Subsequently, we calculate correlation coefficients between productivity and economic growth in order to analyse whether aggregate and sectoral productivity behaves pro-cyclicaly or counter-cyclically, as well as the synchrony relating to the general cycle of such variables. Specifically, a positive (negative) and statistically significant value

[6] Instead of other possible filters, such as that by Kalman (1960) or other Butterworth filters, which allow different structural forms in the cyclical term of the series. See Welch and Bishop (1995), Harvey and Trimbur (2001) or French (2005), among others, for an introduction to these methodological approximations.

[7] The final points (years in this case) of the sample are always a matter of debate in trend-filtering methodology. The reason is that it normally uses moving averages to smooth the series, so both past and future values of the series are required to estimate the intermediate values. Although very similar results are obtained for the intermediate periods with the majority of methods, this does not occur for the final years of the sample. Given the importance of the recession observed at the end of the period analysed, the HP filter is the optimum choice of methodology for this work. However, some experiments demonstrate that the results would not have changed significantly if we had used other filters.

[8] See King and Rebelo (1993), Cogley (1990), and Harvey and Jager (1991), among others.

indicates that productivity is pro-cyclical (counter-cyclical), while values close to zero mean a periodical non-correlation between both variables. For quarterly data, we use a cut-off point of 0.35, approximating the values that reject the hypothesis that the correlation is null at a significance of 5 per cent in a two-tailed t distribution[9]. Additionally, if the correlation coefficient registers its maximum value (in absolute terms) during the period *t-i*, *t* or *t+j*, we will state that the cycle is leading for *i* periods, coincident, or lagging for *j* periods compared to the general cycle, respectively.

3.2. Aggregate results obtained

Several works have demonstrated in recent decades the correlation existing between labour productivity and economic cycle at an aggregate level[10], based on different measurements of final production. According to all of these works, labour productivity has a *pro-cyclical behaviour*. However, this does not prevent, at a sectoral level or in the case of specific countries, productivity behaviour from being *acyclical* or even *counter-cyclical* (Maroto, 2010). In the specific case of Spain, it seems clear that labour productivity is *counter-cyclical* on an aggregate basis, at least since the mid-1990s. Now we will demonstrate this fact statistically and also try to provide some explanations from the sectoral viewpoint about why the Spanish case is different from the majority of cases under study in specialist literature.

Table 1 shows the basic results of the decomposition analysis previously described (trend and cyclical fluctuation). Data shows production, employment and productivity growth rates, both real and corrected by seasonality and calendar effects[11], as well as trend components and cycle growth rates. The results shown do not only correspond to the whole period of 1995-2011, but also differentiate between two subperiods: pre-crisis or expansive period (1995-2006), and crisis or recessive period (2007-2011).

[9] In line with other relevant works such as those carried out by Rosenthal (1991), Kim *et al*. (2003), Dimelis (2001), Fiorito and Kollintzas (1994), Christodoulakis *et al*. (1995) and Maroto (2010), among others.

[10] See, among others, Kydland and Prescott (1982), Hansen (1985), Prescott (1986), McCallum (1989), Benhabib et al. (1991), Hansen and Wright (1992), and Bencivenga (1992).

[11] Series directly offered by the INE in its Quarterly National Accounts.

Table 1
Growth[1] in production, employment and productivity in Spain (Real and corrected series, trend and cycle)

	Production	Employment	Productivity per worker	Hours	Productivity per hour
1995-2011					
Real	1.09	0.41	0.67	0.20	0.63
Corrected	1.12	0.43	0.69	0.24	0.65
Trend	1.15	0.45	0.70	0.25	0.65
Cycle	-0.03	-0.02	-0.01	-0.01	0.00
1995-2006					
Real	1.60	0.79	0.81	0.54	1.02
Corrected	1.54	0.79	0.75	0.64	0.83
Trend	1.52	0.73	0.79	0.58	0.82
Cycle	0.02	0.06	-0.04	0.06	0.01
2007-2011					
Real	-0.35	-0.64	0.29	-0.35	0.01
Corrected	-0.03	-0.55	0.52	-0.39	0.35
Trend	0.11	-0.35	0.45	-0.27	0.38
Cycle	-0.14	-0.20	0.06	-0.11	-0.03

[1] Growth rates compared to the previous quarter.

Source: Prepared by the authors on the basis of the Quarterly National Accounts (INE, 2012)

The main conclusion drawn from the data shown in Table 1 is the overall small weight of the cyclical component, together with the opposite behaviour registered by production and employment on one side, and by productivity on the other, during the years ranging from the beginning of the crisis to date. In particular, we can observe that the cyclical component for the whole period 2007-2011 only means 2.3 per cent, 3.1 per cent and 0.5 per cent of the real corrected growth of the five variables under analysis. Nevertheless, the effect of the cycle on the growth of such variables has been much more significant during the crisis period. Specifically, the cyclical behaviour has registered 450 per cent in the case of national GDP, while percentages in the case of employment and productivity have been 37, 30, 13 and 7 per cent, respectively.

So far, we have analysed the real and trend evolution together with the cyclical component. However, as our objective is to analyse productivity and the cycle, Figure 3 shows the evolution of the cyclical component of production, employment and productivity of the Spanish economy from the mid-1990s until the beginning of 2011. This comparison demonstrates a number of interesting facts that are worth highlighting.

Generally, two conclusions have been obtained from the data:

- Firstly, the reduction of volatility of the Spanish cycle[12], which was evident since the 1950s (Cuadrado and Ortiz, 2001), has continued until the middle of the first decade of the 21st century. However, since the year 2006, this volatility has undergone a significant change and the volatility of the Spanish cycle has increased notably during the crisis period.

- Secondly, the expansive periods have lasted longer than those in which the Spanish economy has been in recession. Although the period analysed in figure 3 does not include more than one example of each kind, several recent studies carried out by the Fundación BBVA seem to indicate that the duration of the current recessive cycle will not be as long as the expansive cycle ending in the year 2007.

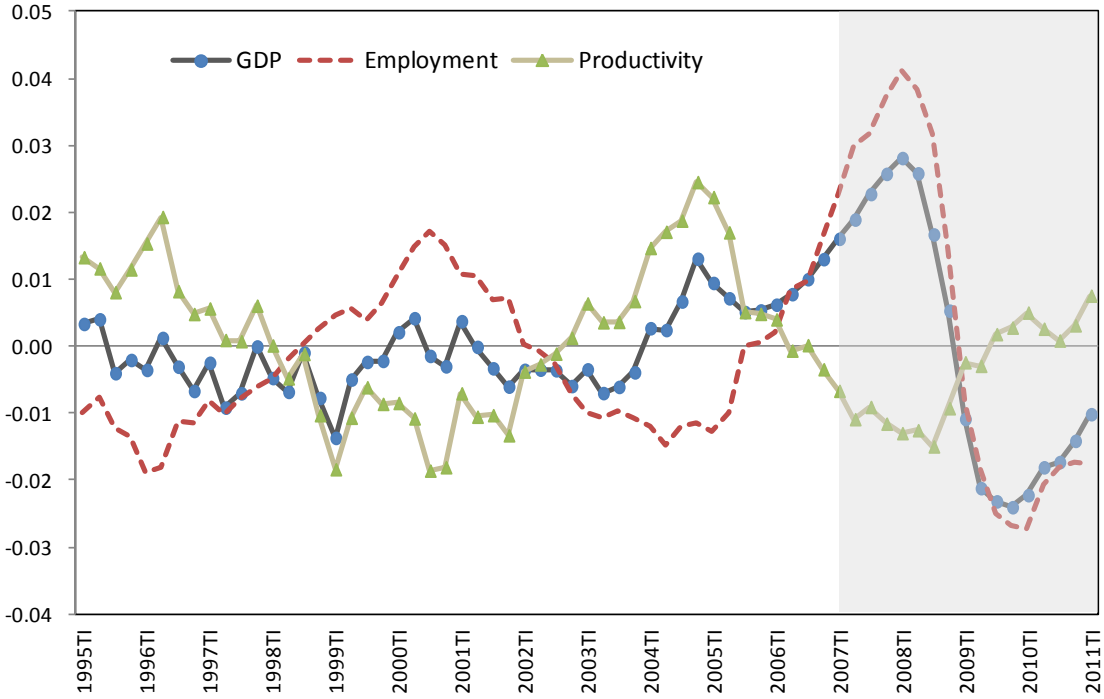
Figure 3 also shows the first conclusions regarding the relationship between the cycles of Spanish productivity and those of production and employment. The following is worth noting:

i) The relationship between economic and employment growth (both in number of workers and hours worked[13]) registers a significant change between the two periods analysed. Although the relationship between both cyclical components is positive for the whole period from 1995 to 2011 (with a correlation coefficient equal to 0.77 in the case of number of workers and 0.89 in the case of hours worked, with *p*-values of 0.00 in both cases), this pro-cyclical relationship of employment is forced by the crisis period (where the correlation coefficient amounts to 0.99 and 0.98, respectively, with *p*-values of 0.00). During the period between 1995 and 2006, the relationship was positive, but not significant.

[12] This phenomenon has been observed not only in the Spanish case, but also in other countries, mainly according to works by the National Bureau of Economic Research (NBER).

[13] Where data availability is insufficient; the Quarterly National Accounts by the INE only offer data on worked hours from the first quarter of the year 2000.

Figure 3
Comparison of the Spanish cycle. Production, employment and productivity



Source: Prepared by the authors on the basis of the Quarterly National Accounts (INE, 2012)

ii) Regarding the level of productivity per worker and that of productivity per worked hour, the relationship with the economic cycle is slightly negative for the whole period (-0.11 and -0.06, respectively). However, this counter-cyclical behaviour of Spanish productivity is much more significant in the recent crisis period, in which the correlation coefficients have been 0.89 and -0.52, with *p*-values of 0.00 and 0.02, respectively. On the contrary, before this crisis, the relationship was slightly pro-cyclical (with correlation coefficients around 0.5).

4. SECTORAL ANALYSIS: FUNDAMENTAL RESULTS AND THE VOLATILITY PROBLEM

In the previous section, we presented some stylised facts regarding the cyclical behaviour of the Spanish productivity at an aggregate level. The main conclusion drawn is that, contrary to what happens in other countries and cyclical phases, productivity in recent years has had significant *counter-cyclical* behaviour. However, such behaviour could presumably be influenced by the sectoral structure of the Spanish economy and the possible varied responses of the different economic

sectors to the economic cycle, among other variables that will not be analysed here. This is particularly so in the case of those sectors with the highest weight in the overall economic fabric, such as some service and manufacturing industries. This reason justifies the analysis of the cyclical behaviour of the Spanish productivity on a sectoral basis.

As for the economy as a whole, the trend and the cyclical component have been obtained by filtering the real series corrected by means of the HP filter. Consequently, the cycle will be the difference between the corrected series in logarithms and the trend obtained through the referred filter. The results achieved for the sectoral GAV and the sectoral productivity are summarised in figures 4a and 4b below. Although the calculations have been made for all sectors, the charts included only show the evolution of the overall economic cycle and the cyclical component of manufacturing, construction and services.

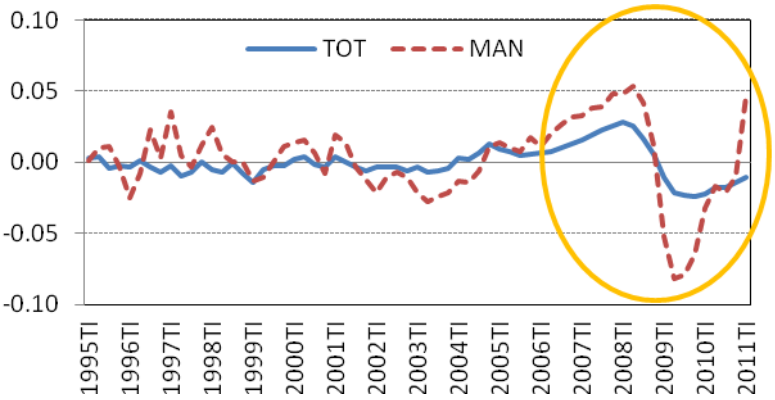
On the basis of these estimates, some initial conclusions can be established from the perspective of sectors:

- Regarding the production cycle (figure 4a), all the sectors analysed register a pro-cyclical behaviour from 1995 to 2011. The correlation coefficients are equal to 0.78, 0.74 and 0.87 respectively. However, this behaviour is mainly due to the highly positive correlation observed since the year 2007 among the sectoral cyclical components and the overall cycle (with coefficients equal to 0.86, 0.90 and 0.96 respectively).

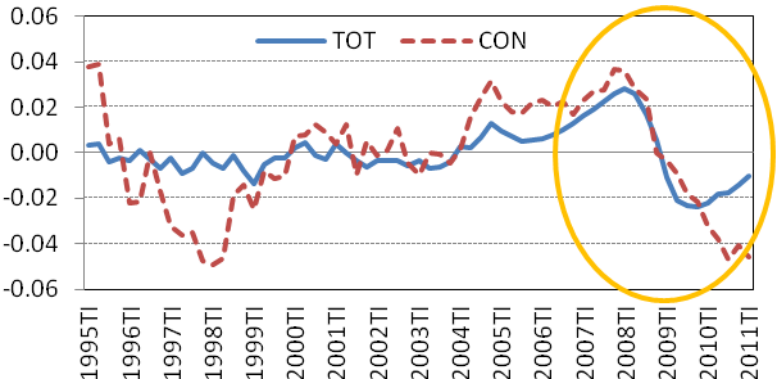
- As regards to the cycle of labour productivity (figure 4b), although positive correlations are also observed between the sectoral cycles and the overall one, this pro-cyclical behaviour (with correlation coefficients equal to 0.54, 0.72 and 0.85) is less significant than in the case of GVA. Additionally, during the crisis period, this positive relationship is even less significant than in the previous expansive period (with coefficients equal to 0.20, 0.83 and 0.64 respectively).

Figure 4a
Comparison of the economic cycle by sectors in Spain. Sectoral GVA, 1995-2011

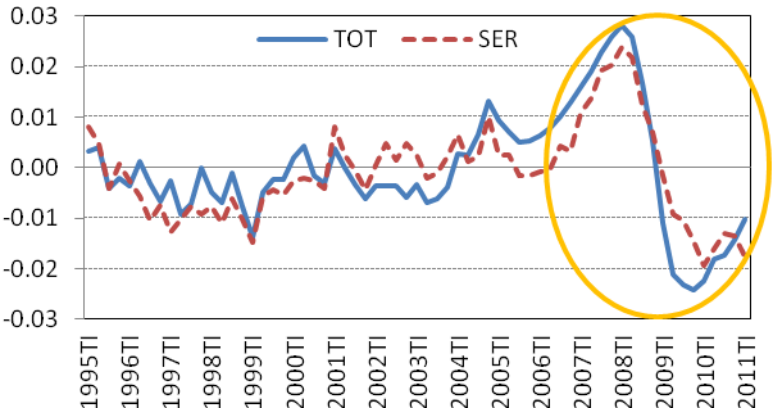
a) Manufacturing



b) Construction



c) Services

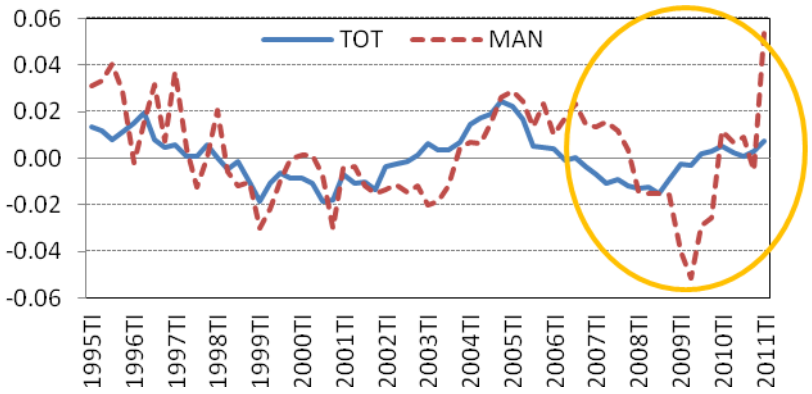


Source: Prepared by the authors on the basis of the Quarterly National Accounts (INE, 2012)

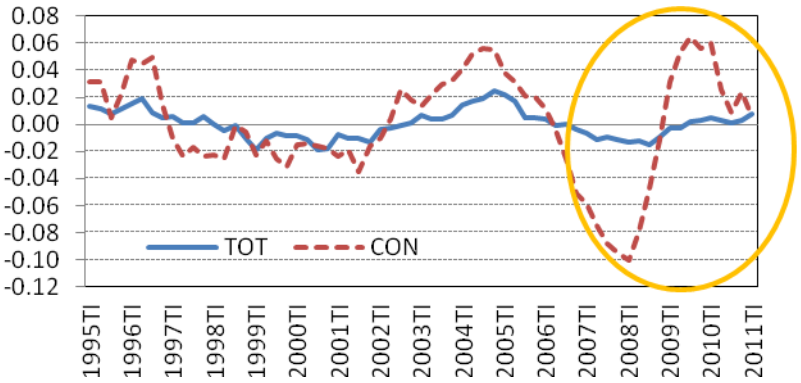
Figure 4b

Comparison of the economic cycle by sectors in Spain. Sectoral productivity, 1995-2011

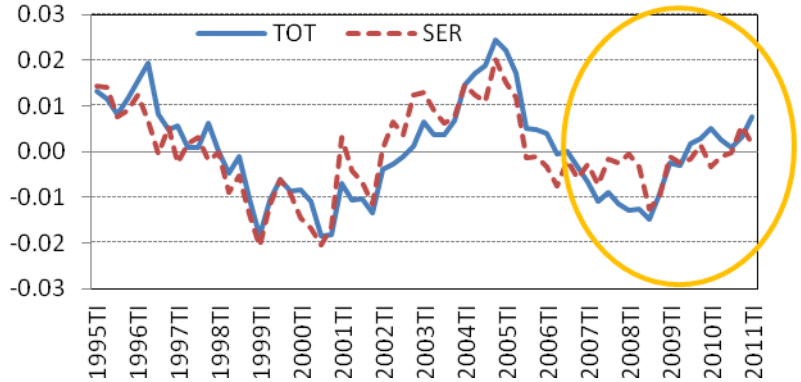
a) Manufacturing



b) Construction



c) Services



Source: Prepared by the authors on the basis of the Quarterly National Accounts (INE, 2012)

Furthermore, the most recent works on cycles commonly explore their behaviour through some statistics that can provide a better understanding of these patterns than the graphic analyses and the correlations previously presented. For this reason, we can estimate *volatility* (measured as the standard deviation of cyclical fluctuations of the analysed variable) and *relative volatility* (measured as the quotient between the volatility of the reference variable – generally GDP – and the volatility of the rest of the analysed variables). Both provide a clearer image of the magnitude of cyclical fluctuations, as well as of their relationship with the overall cycle. As far as the sectoral analysis that we are performing in this subsection is concerned, the use of these indicators seems to be mandatory.

Table 2 exhibits the estimates regarding the volatilities of sectoral productivity in Spain during the period of 1995-2011. We have divided this period into two subperiods for clarity, in line with the methodology used in this work. The first one is an expansive period (1995-2006) and has a higher relativity, not only in the overall economy (1.1) but also in agriculture (4.6 vs 3.9) and the service sector (0.9 vs 0.6). Alternatively, the subperiod dominated by the crisis shows a lower overall volatility (0.7), although higher relative volatilities are observed in manufacturing (3.4 vs 1.7), construction (8.2 vs 2.6) and energy (5.7 vs 2.4).

The indicators shown in table 2 confirm the cyclical behaviour described above for the main activity sectors, both from the overall and sectoral perspective. The rest of the sectors register a higher volatility than the economy as a whole, with the only exception of the service sector (mainly promoted by the market services, as non-market services present a completely different cyclical behaviour). This fact coincides with the results of other works on the Spanish cycle, such as those by Cuadrado and Ortiz (2001) or Maroto (2011).

In order to complement the analysis performed, we have carried out a study on *cyclical synchrony* between sectoral productivity and the economic cycle, aiming to contrast the hypothesis of the possible *counter-cyclical* behaviour of Spanish productivity. To this end, we have estimated correlation coefficients between different periods of time, either leading, coincident or lagging, of the variable under study and the reference variable (which in this case will be the overall economic cycle or the cyclical fluctuation of national GDP). This reflects the level of coherence and synchrony among the cycles. Therefore, we will consider that productivity is *pro-cyclical* if its fluctuations follow the same direction as the economic cycle and thus show a positive correlation. If the fluctuations of both variables are opposite (i.e. when the cycle is expansive the cycle of the variable contracts and viceversa), productivity will be considered to be *counter-cyclical*. Finally, if there is no relationship between them, productivity will be *a-cyclical.*

Table 2
Cyclical volatility of sectoral productivity in Spain

	Total	Agriculture	Energy	Manufacturing	Construction	Services
			1995-2011			
Volatility	1.04	4.55	3.07	2.06	3.94	0.93
Rel Volatility	1.00	4.39	2.96	1.99	3.80	0.89
			1995-2006			
Volatility	1.09	4.98	2.62	1.85	2.83	1.04
Rel Volatility	1.00	4.57	2.41	1.70	2.59	0.95
			2007-2011			
Volatility	0.73	2.86	4.19	2.50	5.99	0.43
Rel Volatility	1.00	3.91	5.72	3.42	8.19	0.59

Source: Prepared by the authors on the basis of the Quarterly National Accounts (INE, 2012)

On the other side, it is also worth noting that aggregate and sectoral productivity may lead, coincide or lag in its cycle compared to the overall economic cycle. It will lead when rises (falls) occur sooner than in the economic production. In contrast, if these rise (falls) occur as a result of some fluctuations in the economic activity, we will say that productivity is lagging. Finally, if the variations occur at the same time, the variables will be coincident.

To analyse *coherence* and *synchrony*, we calculate the correlation coefficients ρ_j between the different lagging and leading periods, up to a total of five periods ($j \in 0, 1 \ldots 5$). We assume that productivity is *pro-cyclical* (counter-cyclical) if the highest correlation coefficient is *positive* (negative) and higher than 0.5 (in absolute value). When the highest correlation coefficient is lower than 0.5, we can state that productivity is *acyclical*. Furthermore, another aspect for consideration could be whether the productivity cycle is *leading*, *coincident* or *lagging* in comparison with the overall economic cycle. This will be deduced when the maximum correlation coefficient is obtained for $j > 0$, $j = 0$ or $j < 0$, respectively.

Table 3
Coherence and cyclical synchrony of sectoral productivity in Spain

	Total	Agriculture	Energy	Manufacturing	Construction	Services
			1995-2011			
Coherence	Acyclical (-)	Acyclical (-)	Acyclical (-)	Pro-cyclical	Counter-cyclical	Acyclical (+)
Synchrony	Leading (2)	Lagging (5)	Lagging (4)	Lagging (3)	Coincident	Leading (4)
			1995-2006			
Coherence	Acyclical (+)	Acyclical (-)	Acyclical (+)	Pro-cyclical	Acyclical (+)	Acyclical (+)
Synchrony	Coincident	Lagging (5)	Leading (5)	Leading (1)	Lagging (5)	Coincident
			2007-2011			
Coherence	Counter-cyclical	Pro-cyclical	Acyclical (+)	Pro-cyclical	Counter-cyclical	Pro-cyclical
Synchrony	Leading (1)	Leading (5)	Leading (1)	Lagging (4)	Coincident	Leading (3)

NOTE: Between brackets, the sign of the correlation in the case of coherence and the number of delays in the case of synchrony.

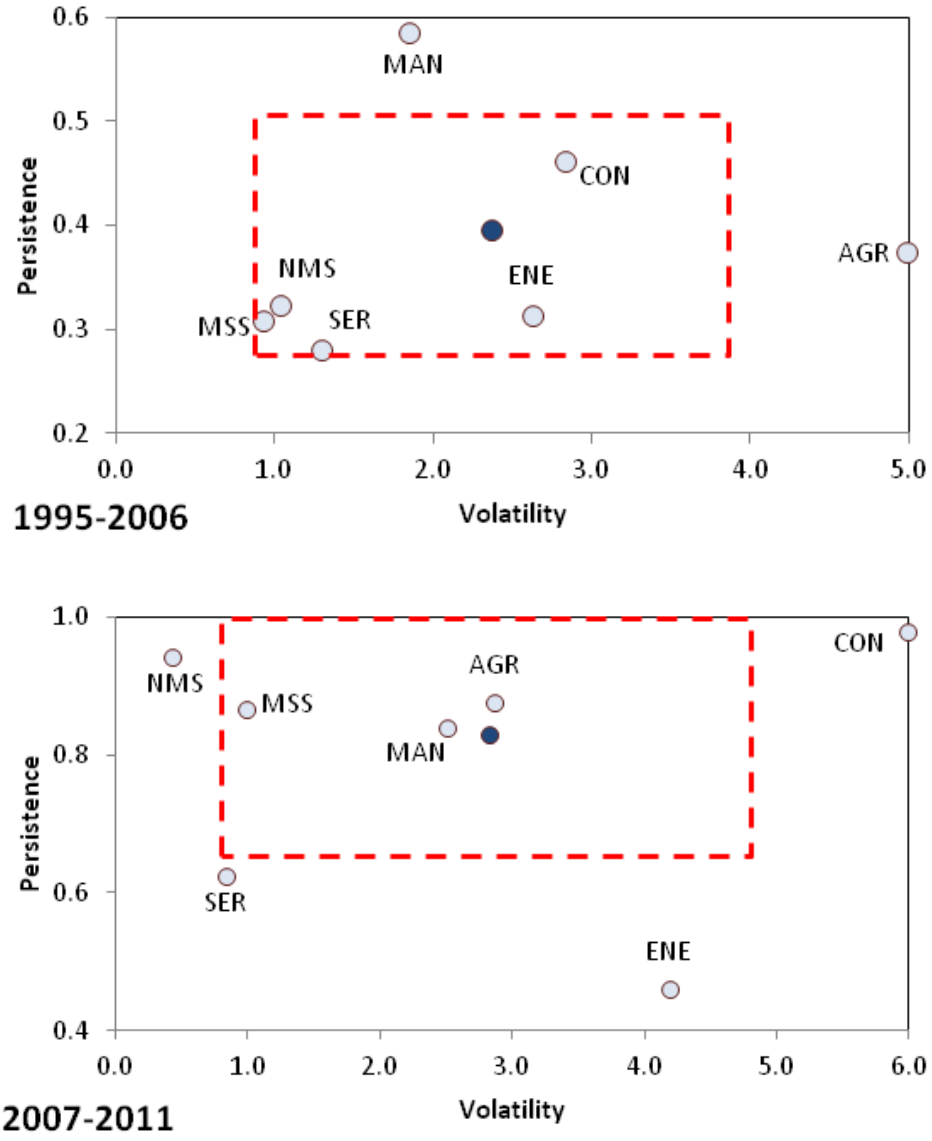
Source: Prepared by the authors on the basis of the Quarterly National Accounts (INE, 2012)

Table 3 lists the main results obtained, not only regarding the coherence, but also the cyclical synchrony of the sectoral productivity in Spain, always referring to the period as a whole herein analysed. What we can infer from these results is that, in aggregate terms, Spanish productivity has a highly differentiated behaviour before and after the beginning of the crisis, as has been highlighted throughout this paper. While the pattern was *acyclical* between 1995 and 2006 (although with a positive and coincident relationship) this has become *counter-cyclical* (and statistically significant) and slightly *leading* (one period) in recent years. Due to this fact, Spanish labour productivity has recorded the growth explained in the previous section, while the overall economic activity has undergone a significant recession, as the rest of the surrounding European economies, although for a more extensive time period than many of them.

On a sectoral basis, we can observe well differentiated cyclical behaviours. On one side, the Construction sector shows a very similar pattern to that of the overall economy, as the sign of its relationship with the sign of the economy has shifted from being positive to negative during the crisis. However, the case of Agriculture is quite the opposite, and Services and Manufacturing register a different pattern to that of

the economy as a whole. Before the crisis, the productivity of these two sectors was *acyclical*, despite its positive sign, while this relationship has not registered any changes during the crisis, but the positive correlation has intensified with the general cycle of the Spanish economy.

Figure 5
Volatility and persistence of productivity in Spain, 1995-2011



Source: Prepared by the authors on the basis of the Quarterly National Accounts (INE, 2012)

To conclude this analysis on the cyclical behaviour of Spanish productivity, figure 5 summarises the information presented so far. In particular, volatility (measured through the standard deviation of cyclical

fluctuations) and persistence (measured through the correlation coefficient that delimited the coherence previously shown in table 3) of sectoral productivity in Spain are jointly exhibited for the two subperiods under study in this work.

The dotted-lined rectangle describes the area that delimits a standard deviation compared to the unweighted average of all sectoral values. The classical theory would suggest that the majority of sectors would be inside or around that rectangle. During the period prior to the economic-financial crisis, the only exceptions were Manufacturing and Agriculture, while only the Energy sector is the exception in more recent years. The data corresponding to the rest of the sectors suggests that the cyclical fluctuations of sectoral productivity in Spain have a similar duration and intensity to aggregate productivity, although the intensities observed during the period of crisis (bottom chart) are slightly higher than in the previous expansive period.

5. FINAL REMARKS

The matter dealt with in this article is not closed with the results drawn; in fact, several working lines are still open for future research. However, the analyses that served as the basis for this work have produced some significant results that can be concluded here.

Firstly, it is a known fact, and we have demonstrated it again, that the cyclical fluctuations that economies undergo clearly affect productivity, implying that the changes shown by the evolution of this variable should be analysed taking the effects of the cycle into consideration. To this regard, the Spanish case is paradigmatic. The deep economic-financial crisis which started in 2007 has had a great impact on the Spanish economy, mainly regarding labour shedding. This has become the main explanatory factor of the rises in labour productivity which occurred from 2008 to 2011. Advanced data referring to 2012 shows that this shift has continued, and this is neither due to a capital deepening nor, probably, to an intense introduction of new technologies. The fall in employment is the main explanatory factor, to which we should add organisational changes in the companies whose effects are still difficult to assess.

The study performed allows us to demonstrate other interesting aspects of the relationship between productivity and cycle. The first one is that, unlike what occurred and still occurs in many countries, in the sense of the *pro-cyclical* nature shown by the evolution of productivity, this variable behaves on a *counter-cyclical* basis in the Spanish case. It was already so in the most expansive phase of the Spanish economy (1995-2006), with very low rates of variation in productivity, and it has occurred since the beginning of the crisis, with annual variation rates above or very near 2 per cent. The main explanation can be found in the

type of jobs created during the expansive period – in sectors registering very low productivity rates – and in the generalised labour shedding that took place and still is taking place since the start of the crisis.

Our analysis has also contributed adequate responses to questions such as volatility of the cycle which, although it was clearly evident until 2005-2006, has undergone a very significant change from the latter year in the sense that the volatility of the Spanish cycle in the crisis has increased. On the other hand, the study of coherence and cyclical synchrony has led us to conclude that the Spanish (labour) productivity exhibits a quite varied evolution before and after the crisis.

One of the most interesting aspects of this work is the sectoral analysis of productivity. Briefly, the results are as follows: agriculture is *acyclical* and *lagging* until 2006, and *pro-cyclical* and *leading* from the beggining of the crisis. The manufacturing sector is *procyclical* before and after the crisis, although with a *leading* and *lagging* synchrony in the two subperiods analysed. Services were *acyclical* and their synchrony was *coincident* during the expansive phase, but these become *pro-cyclical* and *leading* between 2007 and 2011. Finally, the construction sector shows a behavioural pattern that is nearly the same as that of the overall economy, thus shifting from a positive to a negative sign in the two subperiods. Therefore, we draw an interesting conclusion from these results: the atypical behaviour of Spanish productivity cycle is highly influenced by the behaviour of two of the activities on which the national productive fabric has been based in recent decades: construction and some end-consumer service activities, both being sluggish and with intensive labour shedding in recessive phases such as the present one.

As previously noted in this final section, this work leaves several questions open to further research. Undoubtedly, productivity is one of the key problems to be tackled in order that the Spanish economy can grow steadily in the future. The improvement demonstrated by productivity since the crisis began is basically due to the strong labour shedding that has taken place and continues to do so, rather than to the improvements made in terms of capital allocation per worker, the incorporation of new technologies and organisational changes in the companies. Incentives are also necessary to encourage competitiveness as a catalyst for a positive and lasting shift of such a variable. As mentioned at the beginning of this article, sustained improvement of productivity is essential to guarantee economic growth and collective welfare.

6. REFERENCES

BBVA (2010). LA PRODUCTIVIDAD EN ESPAÑA. CRECIMIENTO Y CRISIS. CUADERNOS FUNDACIÓN BBVA, CAPITAL Y CRECIMIENTO, 3/2010, MADRID

- (2000). WHY PRODUCTIVITY IS PROCYCLICAL. WHY DO WE CARE? FEDERAL RESERVE BANK OF CHICAGO WORKING PAPER, 2000-11, FEDERAL RESERVE BANK OF CHICAGO, CHICAGO.

BENCIVENGA, V. (1992). AN ECONOMETRIC STUDY OF HOURS AND OUTPUT VARIATION WITH PREFERENCE SHOCKS. INTERNATIONAL ECONOMIC REVIEW, 33(2): 449-71.

BENHABIB, J., ROGERSON, R., Y WRIGHT, R. (1991). HOMEWORK IN MACROECONOMICS: HOUSEHOLD PRODUCTION AND AGGREGATE FLUCTUATIONS. JOURNAL OF POLITICAL ECONOMY, 99(1), 166-87.

BLACKBURN, K., Y RAVN, M. (1991). BUSINESS CYCLES IN THE UK: FACTS AND FICTIONS. ECONOMICA, 59(236): 383-401.

CAMAGNI, R. Y CAPELLIN, R. (1985): 'LA PRODUCTIVITÉ SECTORIELLE ET LA POLITIQUE RÉGIONALE', EUROPEAN COMMISSION, REPORT. BRUSELAS

CHRISTODOULAKIS, N., DIMELIS, S., Y KOLLINTZAS, T. (1995). COMPARISONS OF BUSINESS CYCLES IN THE EC: IDYOSINCRACIES AND REGULARITIES. ECONOMICA, 62(245), 1-27

COGLEY, T. (1990). SPURIOUS BUSINESS CYCLE PHENOMENA IN HP DETRENDED SERIES. UNIVERSITY OF WASHINGTON, MIMEO, WASHINGTON D.C.

CUADRADO-ROURA, J.R., Y ORTIZ, A. (2001). BUSINESS CYCLE AND SERVICE INDUSTRIES: GENERAL TRENDS AND THE SPANISH CASE. THE SERVICE INDUSTRIES JOURNAL, 21(1), 103-122.

CUADRADO-ROURA, J.R (DIR.) Y OTROS (2010): EL SECTOR CONSTRUCCIÓN EN ESPAÑA: ANÁLISIS, PERSPECTIVAS Y PROPUESTAS. ED. COL. LIBRE DE EMÉRITOS, MADRID

DIMELIS, S. (2001). INVENTORY INVESTMENT OVER THE BUSINESS CYCLE IN THE EU AND THE US. INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS, 71(1): 1-8.

FIORITO, R., Y KOLLINTZAS, T. (1994). STYLIZED FACTS OF BUSINESS CYCLES IN THE G-7 FROM A REAL BUSINESS CYCLES PERSPECTIVE. EUROPEAN ECONOMIC REVIEW, 38(2), 235-69

FRENCH, M. (2005). A NONLINEAR LOOK AT TREND MFP GROWTH AND THE BUSINESS CYCLE: RESULTS FROM A HYBRID KALMAN/MARKOV SWITCHING MODEL. FINANCE AND ECONOMICS DISCUSSION SERIES, 2005-12, FEDERAL RESERVE BOARD, WASHINGTON D.C.

GORDON, R. (2003). HI-TECH INNOVATION AND PRODUCTIVITY GROWTH: DOES SUPPLY CREATE ITS OWN DEMAND? NBER WORKING PAPERS, 9437, NBER, CAMBRIDGE.

HANSEN, G. (1985). INDIVISIBLE LABOR AND THE BUSINESS CYCLE. JOURNAL OF MONETARY ECONOMICS, 16(3): 309-29.

HANSEN, G., Y WRIGHT, R. (1992). THE LABOUR MARKET IN REAL BUSINESS CYCLE THEORY. FEDERAL RESERVE BANK OF MINNEAPOLIS QUARTERLY REVIEW, 16(2): 2-12.

HARVEY, A.C., Y JAEGER, A. (1991). DE-TRENDING STYLISED FACTS AND THE BUSINESS CYCLE. DISCUSSION PAPER, EM/91/230, SUNTORY-TOYOTA INTERNATIONAL CENTER FOR ECONOMICS AND RELATED DISCIPLINES, LONDRES.

HARVEY, A.C., Y TRIMBUR, T. (2001). GENERAL MODEL-BASED FILTERS FOR EXTRACTING CYCLES AND TRENDS IN ECONOMIC TIME SERIES. CAMBRIDGE UNIVERSITY, MIMEO, CAMBRIDGE.

HODRICK, R., Y PRESCOTT, E.C. (1997). POST-WAR US BUSINESS CYCLES: AN EMPIRICAL INVESTIGATION. JOURNAL OF MONEY, CREDIT AND BANKING, 29(1), 1-16.

INKLAAR, R., Y MCGUCKIN, R. (2003). STRUCTURAL AND CYCLICAL PERFORMANCE. IN M. O'MAHONY Y B. VAN ARK (EDS.), EU PRODUCTIVITY AND COMPETITIVENESS. AN INDUSTRY PERSPECTIVE (CHAPTER IV). BRUSELAS: EUROPEAN COMMISSION.

KALMAN, R. (1960). A NEW APPROACH TO LINEAR FILTERING AND PREDICTION PROBLEMS. JOURNAL OF BASIC ENGINEERING, 82(D): 35-45.

KIM, S., KOSE, M., Y PLUMMER, M. (2003). DYNAMICS OF BUSINESS CYCLE IN ASIA: DIFFERENCES AND SIMILARITIES. REVIEW OF DEVELOPMENT ECONOMICS, 7(3), 462-77.

KING, R., Y REBELO, S. (1993). LOW FREQUENCY AND REAL BUSINESS CYCLES. JOURNAL OF ECONOMIC DYNAMICS AND CONTROL, 17(1-2): 207-31.

KYDLAND, F., Y PRESCOTT, E.C. (1982). TIME TO BUILD AND AGGREGATE FLUCTUATIONS. ECONOMETRICA, 50(6): 1345-70.

LUCAS, R. (1977). UNDERSTANDING BUSINESS CYCLES. IN K. BRUNNER Y A. MELTZER (EDS.) STABILIZATION OF THE DOMESTIC AND INTERNATIONAL ECONOMY, CARNEGIE-ROCHESTER CONFERENCE SERIES ON PUBLIC POLICY, 5, AMSTERDAM: NORTH-HOLLAND.

MAROTO, A. (2011). PRODUCTIVITY GROWTH AND CYCLICAL DYNAMICS IN THE SERVICE SECTOR. THE SPANISH CASE. SERVICE INDUSTRIES JOURNAL, 31(5), 725-745

MAROTO, A., Y CUADRADO-ROURA, J.R. (2006) LA PRODUCTIVIDAD EN LA ECONOMÍA ESPAÑOLA, COLECCIÓN ESTUDIOS, INSTITUTO DE ESTUDIOS ECONÓMICOS, MADRID

----- (2009). Is tertiarization an obstacle to productivity growth? A comparative analysis. Structural Change and Economic Dynamics, 20(4), 254-265.

Maroto, A., y Rubalcaba, L. (2008). Services productivity revisited. Service Industries Journal, 28 (3), 337-53.

McCallum, B. (1989). Real business cycle analysis. In R. Barro (Ed.) Modern business cycle theory (Chapter 1, pp. 63-81). Cambridge, MA: Harvard University Press.

O'Mahony, M., y van Ark, B. (2003). EU productivity and competitiveness: An industry perspective. Can Europe resume the catching-up process?Bruselas: European Commission Enterprise publications.

Prescott, E.C. (1986). Theory ahead business cycle measurement. Federal Reserve Bank of Minneapolis Quarterly Review, 10(4): 9-22.

Ravn, M., y Uhlig, H. (2002). On adjusting the HP Filter for the frequency of observations. Review of Economics and Statistics, 84(2), 371-80.

Rosenthal, R. (1991). Meta-analytic procedures for social research. Newbury Park, CA: Sage Publications Inc.

Welch, G., y Bishop, G. (1995). An introduction to Kalman filter. Technical Report, TR95-041, University of North Carolina, Chapel Hill, NC.

Zarnowitz, V., y Ozyildirim, A. (2001). Time series decomposition and measurement of business cycles, trends and growth cycles. Conference Board Working Paper, 01-04, The Conference Board, Washington D.C.

DOCUMENTOS DE TRABAJO

La serie Documentos de Trabajo que edita el Instituto Universitario de Análisis Económico y Social (IAES), incluye avances y resultados de los trabajos de investigación realizados como parte de los programas y proyectos del Instituto y por colaboradores del mismo.

Los Documentos de Trabajo se encuentran disponibles en internet

http://www.iaes.es/doctrab.htm

ISSN: 2172-7856

ÚLTIMOS DOCUMENTOS PUBLICADOS

WP-10/12 REPENSANDO LAS CRISIS FINANCIERAS: EL CASO DE UNA ECONOMÍA EMERGENTE Y CON ARREGLOS CAMBIARIOS RÍGIDOS
Flavio E. Buchieri

WP-01/13 SOBRE LA CRISIS FINANCIERA INTERNACIONAL
Antonio Torrero Mañas

WP-02/13 AUGE Y COLAPSO DE LA DEMANDA DE VIVIEDAS EN ESPAÑA. FACTORES DETERMINANTES
Manuel A. Blanco Losada, Rafael Frutos Vivar, Elena López y Díaz-Delgado y Silvio Martínez Vicente

WP-03/13 CONVERGENCE AND DIVERGENCES IN THE EUROPEAN ECONOMY:REBALANCING AND BEING COMPETITIVE IN A NON-OPTIMAL MONETARY UNION
Ferrán Brunet

WP-04/13 THE PRESENT VALUE MODEL OF US STOCK PRICES REVISITED: LONG-RUN EVIDENCE WITH STRUCTURAL BREAKS, 1871-2010
Vicente Esteve, Manuel Navarro-Ibáñez, María A. Prats

WP-05/13 EDUCACIÓN FINANCIERA PARA JÓVENES: UNA VISIÓN INTRODUCTORIA
José M. Domínguez Martínez

INSTITUTO UNIVERSITARIO de Análisis Económico y Social

Universidad de Alcalá

Plaza de la Victoria, 2. 28802. Alcalá de Henares. Madrid - Telf. (34)918855225
Fax (34)918855211 Email: iaes@iaes.es. www.iaes.es

INSTITUTO UNIVERSITARIO DE ANÁLISIS ECONÓMICO Y SOCIAL