THE HOG CYCLE

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1. INTRODUCTION

The Hog Cycle is a very well known theoretical concept that we are going to prove is taking place in the western countries. The hypothesis on which this kind of Cycle is based resembles the one upon which is based the theorem of Cobweb: The quantity supplied rise as the market price or expected price at sale rises.

The cycle of the hog would develop following a precise pattern: If prices reach a certain high level cattle raisers will be willing to increase the production, this initial impetus will be followed by a time lag, the time that is the one that elapses since pigs are impregnate, until pigs are born and raised. This period of time is of 9-10 months. Given the temporary gap that exists among the decisions of enlarging the production and their materialization in the market, occurs that when the increases of offering are generalized tend to produce a negative effect upon the prices.1

In so far as price falls, expectative about future prices are pessimistic and this produces among cattle raisers a reaction: they reduce their offering by slaughtering the sucking pigs and part of the female pig that are pregnant. By doing this in a few months supply will be reduced and prices will begin to rise. The simple theory outlined before is

1In recent times in which the price of production of the hog was narrowly related to the price of barley, price that, in a closed economy depended at the same time, basically, on the amount of the national crop. We could also think about the existence of a dynamic relation among the supply of porcine and the price of barley, in the sense that a down turn of the price of barley produces in the cattle raisers greater profits expectative, and with it increases in the offering planned.

Currently, when the alimentary component of the hog is a great deal more complex and is fully open to an international market characterized by the stability of the prices, the cycle is observed in the relation among the slaughter and the price perceived by the cattle raisers. This fact, associated with the temporary gap, produces the sinking of the quotations in the price of the product when the new supply reaches the market.
verified inasmuch as the price follows an opposite cycle to the quantity: the Hog Cycle shows that low levels of production cause a rise in prices and vice versa.

Some studies have considered explicitly the hog cycle in Spain. They can be cited to the respect, them carried out by Weinberg and Nephew (1958), and Caldentey (1968, 1980, 1981) that analysed the cycle of the hog in Spain for the period 1959-1977.

The methodology used by Caldentey in order to observe the prices of the pig consisted of applying to the monthly average price received by cattle raisers, once deflected by the general index of prices, a moving average of 12 months in order to eliminate the possible seasonal variations. While the methodology used to determine the slaughters cycle was to regress slaughters series, previously transformed through a moving average of 12 months in order to eliminate the possible seasonal variations, against time. More recent studies about prices and slaughters are based on ARIMA models, Soria (1976), Caldentey y Titos (1979), Albiac (1988) y Parra (1995) have used this technique. Cortiñas developed the harmonic analysis in the study of the Hog Cycle.

2. OBJECTIVES

The aim of this working paper is to describe the Hog Cycle in Spain; special interests will be dedicated to the period 1986-99 because it is during this time that the rules of the common market are applied for the first time to the Spanish market.

This working paper consists of three parts: In the first one we explain the methodology that we have used for this work, in the second we analyze the structural relations between prices of the pig in Spain and demand, and in the last one the monthly series of prices and slaughters are analyzed. Also the recent porcine cycle in Spain and its chronology is described.

3. METHODOLOGY

We understand for cyclical variations the regular fluctuations produced in temporary series of length of more than one year. Temporary series could be formed by several cycles: medium-term, long-term, etc.

Each cycle is defined by two basic characteristics: distance between zero and the maximum value reached during the cycle, and the duration of a complete cycle.

We can define temporary series as the addition of an undetermined number of cycles of different extent and periods. It can be demonstrated that variance of temporary series could be obtained adding the different extensions of the cycles that form temporary series.
In order to obtain the cycles that lead the temporary evolution of series we use the Fourier-transformed. Fourier-transformed $F(u)$, is defined for a real and continuous variable through the following formula:

$$F(u) = \int_{-\infty}^{\infty} f(x) e^{-2\pi iux} dx$$

Where $i = \sqrt{-1}$, $e^{2\pi iux} = \cos(2\pi ux) + i\sin(2\pi ux)$ and $u$ being a variable that represents the different frequencies.

This function has got an inverted transformed, this means that we can calculate $f(x)$ from $F(u)$.

$$f(x) = \int_{-\infty}^{\infty} F(u) e^{-2\pi iux} du$$

As we have already pointed out, the Fourier-transformed is a complex function formed by a real part and an imaginary part, that is,

$$F(u) = R(u) + iI(u)$$

Where $R(u)$ is the real part and $I(u)$ being the imaginary part.

The graphical representation of the function of magnitude $|F(u)|$ is called Spectral density of a time serie and it is represented by the module of the complex number:

$$|F(u)| = \sqrt{R^2(u) + I^2(u)}$$

The square of this function $|F(u)|^2$ is called Power Spectrum.
The graphical representation of the Power Spectrum in relation to the frequencies is called periodogram or empirical spectrum of the serial.

The analysis of the serial through the periodogram allows us to know the leading cycles and its contribution to the explanation of the variance in a percentage basis.

Once we have known the leading cycles, Alvarez (1986) suggests obtaining the theoretical cycle of the serial, superimposing the most relevant ones. The dynamic relations between two temporary series could be analyzed by studying the common peaks of the periodogram.

Another way to analyze the cycle of a temporary serial is to take out the cyclical or trend of the temporary serial by statistical methods. The cycle-trend component will be depurating of seasonal cycles and other more or less disturbing facts that usually affect the economic series.

In order to obtain the cycle-trend of a serial there are different procedures, the most common are, the X11 and X11-ARIMA, both developed by the National Bureau of Census of the United States of America and SEATS (Gómez y Maravall 1996) that is used in Spain and Europe.

In the X11 method the cycle-trend comes from the elimination of the irregular component (or fortuitous influences of instant effect) of a deseasonalized serial using moving averages, calculating the number of terms the serial should have by M.C.D. (Months for Cyclical Averages). M.C.D. indicates the number of terms that we should use in the moving average in order to achieve the dominion of the cycle-trend over the irregular component. One of the most important problems of getting the serial of the cycle-trend through the X-11 method is the huge amount of information that we loose when that serial is very big.

In example, the X-11 method needs of 42 monthly forecast to get the cycle-trend and 84 forecast when is used as a deseasonalized filter. Although the X11 ARIMA method provides forecasts that are used latter to deseasonalize the original serial or to extract the cycle-trend, the proper use of this tool requires the incorporation of forecast to the serial.

SEAT is a method for estimating the terms of a temporary serial (trend, stationary, cycle and irregular component) starting from the decomposition of the ARIMA model. SEAT is the development of a program for seasonal adjustment built by Burman for the Bank of England, the basic references for it are: Cleveland and Tiao (1976), Box, Hillmer, y Tiao (1978), Burman (1980), Hillmer y Tiao (1982), Bell y Hilmer (1984), y Maravall y Pierce (1987). SEAT calculates the terms of the temporary serial without any information cost in the extremes of the temporary serial.

There are several methods for adjusting the trend; basically they rely on regressions against time (fix, moving, exponential, etc.) or in the use of moving averages of enough amplitude in order to eliminate the cyclical component. The most famous one is PAT (Phase Average Trend) developed by National Bureau of Economic Research. This method
use moving averages of 75 terms, which means a high cost of information and leads to inappropriate arrangements for the extremes of the period.

Once we have got the cycle-trend serial, its chronology can be determined by using a cyclical dating system for the serial.

4. STRUCTURAL RELATIONS BETWEEN THE PRICE SERIES AND SLAUGHTERS

In figure 1 we represent the annual slaughters and prices series collected by cattle raisers in Spain for the period 1950-1999. It can be noticed that slaughters and prices have got a very define trend and around it several different cycles are superimposed. Analyzing those cycles it is clear that prices and slaughters move in opposite directions: when prices are high slaughters are low and vice versa. We would also like to point out the high volatility of the price serial of porcine, specially form 1986, date in which Spain joint the UE, volatility could be caused by external influences on prices (German reunification, porcine plague, etc.)

Figure 1 Evolution of slaughters, and porcine prices in Spain
From a spectral analysis of the slaughters serial (figure 2), it can be notice that long-term cycles are dominant; the 48-year cycle explains more than fifty per cent of the serial, there are also important the 24, 12 and 3-year cycles that explain about 10% of the variance.

![Figure 2 Spectrum of slaughters serial](image)

In the serial of prices (figure 3) the long-term cycles are also dominant, the 48-year cycle explains more than 45% of the serial, the 24-year cycle is also important because explains approximately 30% of the variance, we would also like to point out that the 3-year cycle explains around 5% of variance. We find common peaks in both series of the periodogram, in harmonic first-rate (48 months) and harmonic fifteen-rate (3 years).

Starting from the spectral analysis (figure 4) the theoretical cycle is determined for both series. The graph shows that in the shortest cycle, prices and slaughters behave in agreement with the theoretical cycle of porcine: when prices are high slaughters are low and when slaughters are high prices are low.
Once we have represented graphically both theoretical cycles it remains to determine the existence of simultaneity and lags between them. After doing it, we verify that maximum correlation is obtained lagging in two periods the slaughters serial against that of prices collected by cattle raisers. The correlation coefficient obtained is 0.987, which is significant from the statistical point of view.

As we have stated in advance the cattle raisers have a gap between their will to sell and their capacity to do it; their sales are function of the expected price, so when they detect a rising trend in prices they try to increase their capacity and vice versa. In figure number 5, we represent the structural relation between theoretical cycles of both series lagging in two years the slaughters serial, which is the normal period for cattle raisers to adapt their supply according to expected price and to effect of the lag on their expectations.
5. CYCLICAL DATING OF SLAUGHTERS AND PRICES SERIES

In figures 6 and 7 we represent the recent evolution of monthly prices and slaughters of porcine series. Due to behavior observed in the annual series, we have chosen to carry out the analysis of the period that goes from 1986 to 1999, period that corresponds to permanence of Spain inside the EU.

In order to obtain the cycle-trend series, the following ARIMA models have been estimated:

<table>
<thead>
<tr>
<th>Series</th>
<th>Model</th>
<th>Ljung-Box</th>
<th>Box-Pierce</th>
<th>Normality</th>
<th>Kinds of models</th>
<th>Easter Effect</th>
<th>Calendar Effect</th>
<th>Outliers</th>
</tr>
</thead>
<tbody>
<tr>
<td>sacrificios (0,1,1)</td>
<td>(0,1,1)</td>
<td>44,95</td>
<td>2,15</td>
<td>2,267</td>
<td>MULTIPLIABLE</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>precios (0,1,1)</td>
<td>(0,1,1)</td>
<td>30,04</td>
<td>2,31</td>
<td>0,2068</td>
<td>MULTIPLIABLE</td>
<td></td>
<td></td>
<td>AO(11 1998), LS(12 1997), TC(9 1989), LS(6 1997),</td>
</tr>
</tbody>
</table>
As it can be seen in figure 6, the slaughters serial has got a tendency to growth with a clear seasonal component, being the winter months those with a higher level of slaughters, on the contrary the summer period is the one with the fewer number of tones of slaughters.

On the other hand, the national porcine prices (figure 7) show a slightly decreasing trend, at first sight price serial do not have a clear seasonal character but cyclical fluctuations lasting around three years could be appreciated.
Figure 7 Evolution of porcine prices in Spain

Figure 8 Slaughters and price cycles for porcine in Spain
In figure 8 is represented the relation of prices against slaughters, both free of trend effect, in the figure it is clearly shown how an increase of slaughters produces a decrease in prices, showing how the market is unable to absorb the increases of supply without reducing prices. It is worth mentioning what happened during 1995 to 1998 in which the porcine cycle has been altered due to those years’ circumstances. We have to point out that during April 1997 the porcine plague reappear after ten years absence, with serious economic consequences for cattle raisers. The importance of the plague forced the UE to adopt protective measures restricting the porcine trade altering the normal evolution of the market; prices during this period had great volatility due to the uncertainty of the situation. The 24th of July 1998 authorities declared the end of the plague and release the restrictive measures against trade on January the 13th 1999. The appearance of the plague determined the sinking of porcine prices in 52.9% according to collected price index, 52.9% is the difference between the index in May 1997 and January 1999. In the description of the ARIMA model applied to price serial are detailed the number of interventions that help to understand the facts that happened during that period.

The cyclical chronology of prices and slaughters series has been determined through the temporary series automatic date program <F> (Abad y Quilis, 1995)2, you can find the outcomes in table 2 and 3.

<table>
<thead>
<tr>
<th>Date</th>
<th>Minimum/Maximum</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1987</td>
<td>Minimum</td>
<td></td>
</tr>
<tr>
<td>July 1988</td>
<td>Maximum</td>
<td>18 months</td>
</tr>
<tr>
<td>March 1990</td>
<td>Minimum</td>
<td>20 months</td>
</tr>
<tr>
<td>February 1991</td>
<td>Maximum</td>
<td>11 months</td>
</tr>
<tr>
<td>April 1992</td>
<td>Minimum</td>
<td>14 months</td>
</tr>
<tr>
<td>July 1993</td>
<td>Maximum</td>
<td>15 months</td>
</tr>
<tr>
<td>March 1995</td>
<td>Minimum</td>
<td>20 months</td>
</tr>
<tr>
<td>May 1996</td>
<td>Maximum</td>
<td>14 months</td>
</tr>
<tr>
<td>March 1997</td>
<td>Minimum</td>
<td>10 months</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Minimum/Maximum</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 1988</td>
<td>Minimum</td>
<td></td>
</tr>
<tr>
<td>July 1989</td>
<td>Maximum</td>
<td>17 months</td>
</tr>
<tr>
<td>November 1990</td>
<td>Minimum</td>
<td>14 months</td>
</tr>
<tr>
<td>March 1992</td>
<td>Maximum</td>
<td>16 months</td>
</tr>
<tr>
<td>July 1993</td>
<td>Minimum</td>
<td>16 months</td>
</tr>
<tr>
<td>May 1997</td>
<td>Maximum</td>
<td>46 months</td>
</tr>
</tbody>
</table>

2 The automatic date program <F> determines the cyclical behavior of a temporary serial though the location of the turning points (cyclical maximum and minimum). In order to eliminate the turning points due to small residual fluctuations an autoregressive filter is applied. The turning points have to fulfil to basic conditions:
- The distance between two turning points of equal sing cannot be less that a certain number of months (for lack of 15).
- The distance between two non-consecutive turning points of opposite signs must not be less that a certain number of months (for lack of 5 months).
The outcomes show that when we find a minimum in slaughters a maximum of prices must be near that point, that the average distance between a maximum and minimum is 15 months, that means that a complete cycle (a maximum to a minimum or vice versa) last approximately 30 months (two years and a half). The cyclical date of the price serial shows a long-term cycle since 1993 till the actual time due to the uncertainties lived in the porcine market as a result of the porcine plague.

REFERENCES