LONG-RUN AND SHORT-RUN DYNAMICS OF PALM OIL MARKET

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The reconstruction of a hitherto unpublished 180-year palm oil monthly price series, from January 1818 to December 1998 caf Liverpool and Rotterdam, provides the occasion to study the historical market dynamics during nearly two centuries. In the current context of trade liberalisation and withdrawal of state, when attention is more than ever paid to price movement, understanding, explaining and if possible forecasting price volatility are key issues facing both producers and consumers. Last year's Asian crash legitimately raises questions on free markets security : are world commodity markets, like edible oils market, really different from financial markets ? Can their prices abruptly collapse tomorrow and degenerate in crashes similar to those registered in New York in 1987, Tokyo in 1990, Mexico in 1994, South East Asia in 1998 ? What basically creates volatility ? We try here to answer such questions. To this end, the main characteristics of our 180-year monthly series are reported in a first section. We discover that palm oil prices share most of the financial assets properties they are not purely random, they exhibit strong nonlinearities ; and no bounded set holds their variations. Historical switching regime in volatility is the object of the second section. Succession of highly unstable periods and low volatility periods is discussed. We show that ruptures in the dietary structure, trade growth shocks, as well as changes in the geography of trade are the three outstanding features of the twentieth century palm oil trade and the most serious explanatory candidates to price instability. Consequences of the recent leadership of a perennial crop oil like palm oil on the world oils & fats market prices behaviour are addressed in conclusion. Our view is that the occurrence of a crash cannot be rejected.

I) Dynamics of palm oil prices : properties

Palm oil was imported in Great Britain as input for the soap and candles industries as early as 1790. Liverpool would remain the world quotation centre until the end of world war II and the emergence of Rotterdam. Two sources of information reported by Latham (1978) provide us with palm oil price early quotations : *The Liverpool Mercury*, from 1818 to 1843, *The Economist*, from 1844 up to 1946. A French review, *Oléagineux* and the well-known *Oil World*, complete the series until today. As a result we have a hitherto unpublished 180 year palm oil monthly price series : in logarithms (graph 1) and in first differences, that is to say in variations (graph 2). We work on first differences, in accordance with stock returns analysis since our view is to compare palm oil prices characteristics with stock returns.

We study the variance. Variance measures volatility. It shows infinity drift behaviour : volatility is not constant and changes over time (graph 3). Measuring it every year, we obtain a clear two-regime behaviour : as low volatility used to be the rule before 1930's ; high volatility regime seems to have replaced it (graph 4). This result is reinforced by the empirical distribution of price variations which is clearly different from the Normal Law : strong variations succeed to near-zero variations : mean variations are rare and even meaningless (graph 5). Such features are shared by financial assets too.

Second, we seek periodic cycles thanks to Fourier decomposition : we find none (graph 6 : no coefficient emerges). Absence of periodic cycle is observed in financial markets too.

Third, providing that a price movement up or down reflects a gap between supply and demand, we would like to know whether the signal given by the price variation is commensurate with the cause – viz. the gap between supply and demand. Evidence of nonlinearity (table 1 : nonlinearity in variance ; table 2 : nonlinearity in the mean) proves that the effect is not commensurate with the cause : price variations multiply the difference between supply and demand in an always different manner. A very same gap between supply and demand leads to an always different price variation. That is the case in financial markets too.

At last, we look for upper and lower limits in price variations : are they bounded ? Are they not bounded ? Tests of chaos allow to answer. Originally chaos was exhibited in meteorological forecasting models by Lorenz (1963) : he discovered that deterministic equations could generate unpredictable and random-like processes. Random-like but not really random because equations were deterministic. Sensitivity to initial conditions (exponential increase of the slightest error in parameters) and convergence of the trajectories to what is called an "attractor" (global stability of the process) are the two major properties of a chaotic system. The first one prevents from making long-term predictions, the second one ensures that

the system will not depart from a bounded set. We clearly understand what they mean in meteorology : the further the forecasting horizon, the stronger the error. Because of their difficulties to make accurate forecasting, economists have been trying since 15 years to explain their failure by the presence of chaos in prices. Measures and tests have been built to detect chaos. When strictly positive, the *Lyapunov Exponent*, in accordance with Wolf algorithm (1985), detects initial conditions sensitivity (ICS). Lyapunov exponent λ^* has been calculated from our palm oil price series : $\lambda^* = 0.046 > 0$: it is strictly positive. ICS is exhibited in financial markets too.

Attractor dimension's calculation method is due to Grassberger and Procaccia (1983). The dimension of the attractor is measured in a mathematical space whose dimension increases from 1 to 10 : if the dimension of the attractor grows along with the dimension of the embedding space, we conclude that we actually have no attractor. If the dimension of the attractor converges to one particular value whatever the embedding space's dimension, one concludes to the presence of an attractor. We have applied the Grassberger and Procaccia algorithm to palm oil prices : convergence is not clear (graph 7). We are between chaos and randomness. That's the case in financial markets too.

In conclusion, what have we learnt ? Prices display nonlinearity ; they are held in no small size bounded set ; and they are sensible to initial conditions. Implications in terms of predictions is that short-term is less hazardous than long-term. In terms of volatility, no clear upper and lower limits restrain upsurges and downswings. Actually prices show erratic behaviour similar in their properties to the behaviour of stock returns. For what reason since the mechanisms of a commodity market, with constraints of storage, shipping, delivery, and strong emphasis on fundamentals in price expectations, share so little common features with financial markets governed by speculation and sentiment ? Historical analysis sheds some light on this paradox.

II) Switching volatility : causes

The behaviour of financial markets, switching from low volatility regime to high volatility regime, has been convincingly described by Hamilton (1988, 1989), and among others, Schaller et Van Norden (1997), with mathematical tools such as Markov process. Similarly, graph 4 suggests strong switching regime in palm oil prices. It is to its understanding that this section is devoted. Our hypothesis is that to a change in volatility regime should correspond a change in market's structure. We have therefore sought chronological changes in demand, supply, and in the geography of trade from 1818 to 1998.

As we have said, palm oil was first imported to match the demand from soap and candle industries in Great Britain. Competing with tallow from Russia, South America,

Australia and from United States, palm oil was sold on long-term contract basis to Liverpool traders. Invention of margarine by Mége Mouriès in 1869, the improvement of refining process due to Wesson in 1900, and the invention of hydrogenation by Norman in 1902 opened the food market to most edible oils in the beginning of the twentieth century. Most of them except palm oil and whale oil : both would have to wait the beginning of the 1930's to enter world food market. From a nineteenth-century old soap industry with limited demand, palm oil entered at this time a fast growing market in spite of rampant recession. Indeed, in the 1930's, European countries and United States experienced a sudden shift in their consumption pattern. As shown on graph 8 with the case of France, the smooth trend of fats contribution (expressed in gr.) to dietary intake (expressed in calories) which was prevailing in the nineteenth century suddenly broke between 1930 and 1940 : without any significant increase in dietary intake, the share of fats consumption abruptly shot up. After World War II, a more pronounced slope would replace the nineteenth century smooth trend : consumption had shifted from grains to sugar and fats. Similar pattern characterises the 1980's in India and China (graph 9, with the case of China). It is worth noticing that changes in consumption patterns occurred in 1930's and 1980's along with significant volatility growth (graph 4).

On the supply side, should I remind the incredible improvement in palm oil quality (ffa droping below 10%) achieved in Lever's plantation in Zaïre and above all in Sumatra estates just before World War II ? Furthermore, researches developed by Ringoet and Beirnaert in 1933, by Beirnaert et Vanderweyen in 1939, on Tenera hybrids, applied in large scale from 1960's onwards in Malaysian and Indonesian plantations permitted the historical palm oil boom ten years later. At last, introduction of weevil in the beginning of 1980's is one recent major improvement. Let's recapitulate : what are the dates of major changes on supply side ? 1930's, 70's and 80's. They all occurred along with significant volatility growth.

Changes in the geography of trade are no less interesting. After one century of trade between Lagos and Liverpool, a first rupture took place in 1930's when the United States entered the world palm oil market, overshadowing UK (graph 10). Emergence of Asian demand from the end of 1970's onwards (China, India, Pakistan) marks the second shift (graph 11). World market is now working on two scales : a short distance trade inside Asia, a long distance trade between Malaysia, Indonesia and Europe. European demand is twice as far as Asian demand from Malaysian and Indonesian supply. In the same time, European consumption is half of Asian consumption. Two scales of trade, two weighs in trade, and two speeds of reaction : as India, for example, reacts instantly to palm oil prices variations (vessels can reach the East Coast within a week : hedging is not necessary), Europe's reaction takes more time (one month crossing : hedging is necessary). Furthermore, importing edible oils in Rotterdam from South America, Africa or Asia takes approximately an equal time. In India, it is 45 days (South America) against one week (Singapore). All in all, a different timing in buying and selling decisions leads to a contrasting price behaviour : short term instability

stemming from instant reactions in Asia and long term convergence towards an equilibrium in Europe are superimposed. Fundamentals in the short run are not equal to fundamentals in the long run. We will not be surprised to learn that financial markets mechanisms are described in a very same way : short term "speculators" and long term "fundamentalists" are superimposed : the first provide liquidity, the second direct prices towards an equilibrium. On geographical grounds solely, one can in conclusion explain the similarity between commodity prices and stock returns.

CONCLUSION

Starting with statistical properties describing palm oil prices dynamics from 1818 to 1998, we have found that with strong nonlinearities and pseudo chaotic behaviour, palm oil prices shared the salient properties of stock returns and financial assets. Changes in consumption patterns, in supply structure as well as in the geography of trade have then been evoked to explain such properties. Because short distance trade in Asia and long distance trade with Europe are superimposed, we have seen that on solely geographical grounds, we could explain the similarity between palm oil prices and stock returns : by simply converting the distance into time horizon, we reproduce the characteristics of financial market where short term speculators and long term fundamentalists are superimposed. The next questions are : How can we avert crashes? And : Is the leadership of palm oil strengthening the risk or diminishing it? In the current period of oils & fats shortage, the leadership of palm oil should mitigate the price-risk : a perennial crop is much more reliable than an annual crop : we know approximately 1999 world palm oil production, we are much more ignorant of soft oil market's situation. But should supply exceed demand, which has not been the case for long time, and probably would world prices collapse to record-low levels because of palm oil : with current record margins and growing volumes to sell, prices under the leadership of palm oil have unknown lower limit. Symmetry is obvious : in shortage period, perennial crop-oils like palm oil mitigate the risk, while in surplus period, annual crop oils with possible drastic reductions in areas, do mitigate the risk. After all, that is a chance financial markets do not have.

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