

(downwaves). According to Berry *et al.* (1993), upwave growth starts in recessions and ending in stagflation crises that are associated with diffusion of newly structural innovation to market saturation. Downwave growth cycles are associated with technology successions, when peaked-out paradigms are challenged by ascendant sets of techno-economic alternatives, after the shocks of stagflation crises (Ayres, 1990; 1990a; Kleinknecht, 1990; Reati and Toporowski, 2004; de Groot and Franses, 2008).

Devezas *et al.* (2005), analyzing the 4th Kondratieff wave, argue that the inventions appear during the upwave and during the first recession period, whereas innovations clustering all along the downwave and further recession, and finally the widespread diffusion occurring at the trough and transition period into the fifth K-wave: i.e. during the upwave there is the invention phase, whereas innovations clustering and their widespread diffusion are all along the downwave phase.

Although it can be used complicated models and simulations of forecasting (Diebold, 2004) of K-waves, which are ever affected by some bias *ex-post*, this paper applies a simple approach to conjecture the forecast horizon of future K-waves. In particular, starting from historical chronologies of long waves measured by Kondratieff (1935), Ayres (1990; 1990a), Mandel (1980), Van Duijn (1983), Berry and Kim (1994), it is calculated the average upwave phase, based on price index for the USA, that is 29.50 years for the 1st K-Wave; 28.75 years for the 2nd K-wave; 27.50 years for the 3rd K-wave and 29.00 years for the 4th K-wave. The arithmetic mean of these values is 28.69 years, the deviation standard σ is 0.74 years, which indicates the dispersion around the central tendency. Whereas, the average downwave for US economy is 28.50 years for the 1st K-wave; 25.00 for the 2nd K-wave; 26.25 for the 3rd K-wave and 25.00 for the 4th K-wave. The arithmetic mean of these figures is 26.19 years,

the deviation standard σ is 1.43 years.

Mutatis mutandis, it is also calculated the average upwave for the UK economy that is 34.00 years for the 1st K-Wave; 29.50 years for the 2nd K-wave; 25.50 years for the 3rd K-wave, missing values for the 4th K-wave. The arithmetic mean of these values is 29.67 years, the deviation standard σ is 3.47 years. Whereas, the average downwave in UK economy is 24.50 years for the 1st K-Wave; 25.50 for the 2nd K-wave; 25.00 for the 3rd K-wave. The arithmetic mean of these figures is 25.00 years, the deviation standard σ is 0.41, which indicates the dispersion around the central tendency. Table 1 shows these results.

If the joint chronologies of US and UK countries, two driving economies for worldwide economic growth patterns, are considered, the results are described in section 1C of table 1. This empirical analysis shows that average period of long waves over time is roughly 54.94 years with σ equal to 2.37 years. In support of this result, Stewart (1982), fitting total energy and electric energy growth curves with logistics and plotting the residuals as percent deviations from fitting curve, obtains a sinusoidal oscillation of the deviations with a period of about 54 years. Berry (1991) documented that growth rate of prices swing with approximately 54-year rhythms (Kondratieff waves). *Coeteris paribus*, it is supposed that the average period equal to 54.94 years ($\sigma = 2.37$) can be a good proxy of future period (length in years) of K-waves.

Therefore, the forecast horizon of the fifth long wave is from 1992 to 2046.94 (boom year in 2021.15), of the sixth long wave is from 2046.95 to 2101.88 (boom year in 2076.09), of the seventh long wave is from 2101.89 to 2156.82 (boom year in 2131.03). Table 1 shows these fundamental results, whereas figure 1 describes the paths and forecast horizon of future long waves.