Inclination Analysis Can Yield Early-Warning Signals of Economic Recessions

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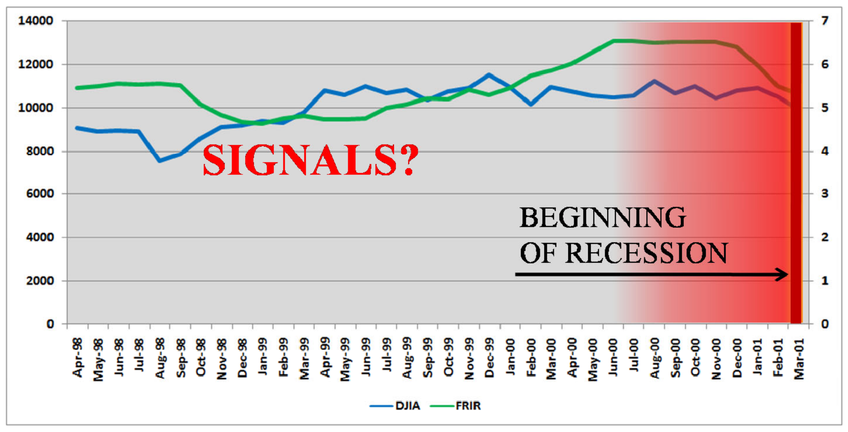
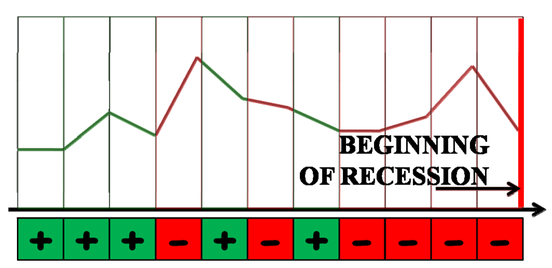
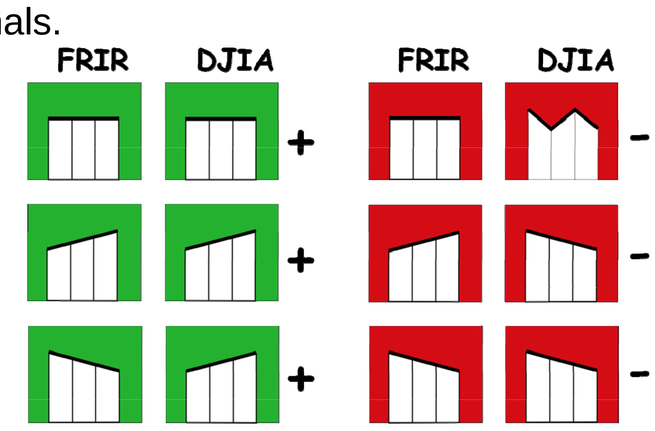
Recognition: Early 2000s recession



- At this stage the goal is to identify pre-cursors of the early 2000s recession (March – November 2001).
- We consider three-year-long financial time series for the DJIA (Dow Jones Industrial Average) and the FRIR (Federal Reserve Interest Rate), representing the monthly data preceding the recession.
- We identify some short patterns in the time series as “minus” signals (which primarily occur close to the time of the recession) and some short patterns occurring, primarily, in earlier periods as “plus" signals.

Recognition of the “-” and “+” patterns hidden in the data series gives us an **INVERSE PROBLEM**



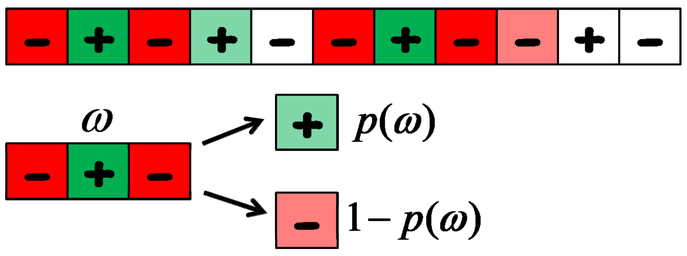


One of the possible encoding rules

- We define a binary encoding rule that transforms short data patterns into “minus” and ”plus” signals.
- Thus, at the recognition stage, we have the methodology for finding such a function (encoding rule) that, for fixed parameters of the model, transforms the real data series into a binary sequence, which identifies early-warning signals of the early 2000s recession. We understand an early-warning signal as a large number of subsequent minuses.

Statistical analysis

- To identify the random process we use a long data series for **1954-1988** (preceding the early 1990s recession) and the function found at the previous stage for the given parameters set.
- We compute the frequencies of the “-” and “+” signals following the historical signal sequences of a given length (the latter acting as a parameter).

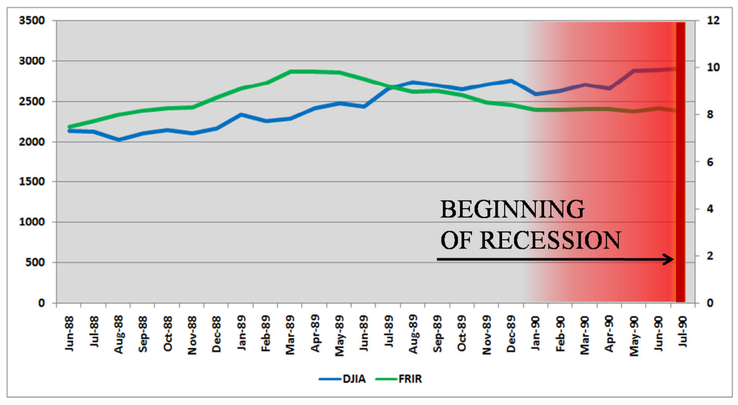


Matrix of transition probabilities

+++	++−	+−+	+−−	−++	−+−	−−+	−−−	
p^{+++}_{+++}	0	0	0	p^{-++}_{+++}	0	0	0	+++
$1-p^{+++}_{+++}$	0	0	0	$1-p^{-++}_{+++}$	0	0	0	++−
0	p^{++-}_{+++}	0	0	0	p^{-+-}_{+++}	0	0	+−+
0	$1-p^{++-}_{+++}$	0	0	0	$1-p^{-+-}_{+++}$	0	0	+−−
0	0	p^{+-+}_{+++}	0	0	0	p^{--+}_{+++}	0	−++
0	0	$1-p^{+-+}_{+++}$	0	0	0	$1-p^{--+}_{+++}$	0	−+−
0	0	0	p^{+--}_{+++}	0	0	0	p^{---}_{+++}	−−+
0	0	0	$1-p^{+--}_{+++}$	0	0	0	$1-p^{---}_{+++}$	−−−

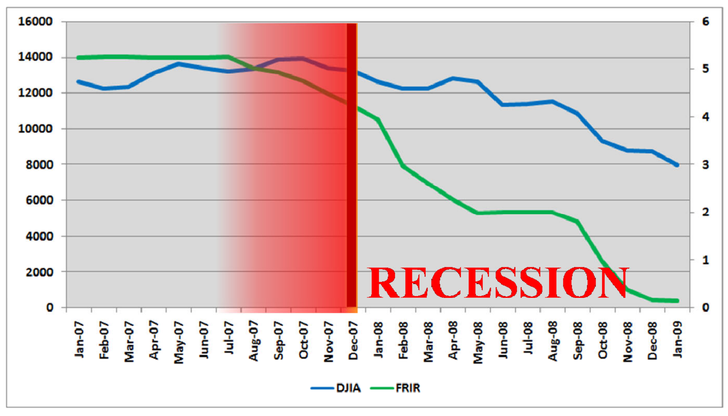
- We treat the frequencies as transition probabilities.
- We organize the transition probabilities in a matrix, which defines a binary random process operating in the space of the binary windows.

Training: Early 1990s recession

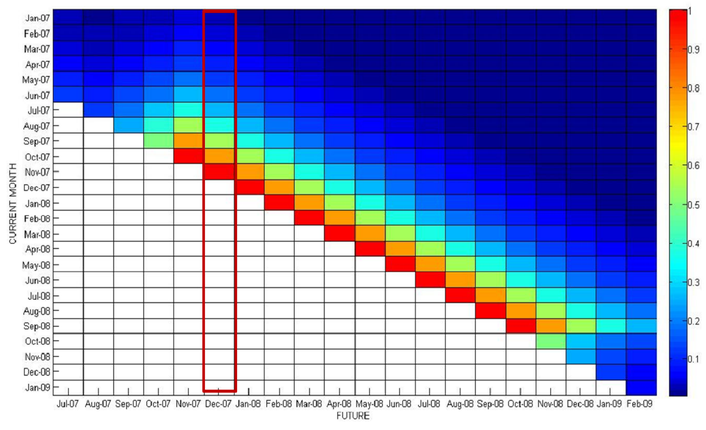


- We train the model with the data preceding another recession, the one in the early 1990s (Jul 1990-Mar 1991).
- We use the model to retrospectively assess the probability of a recession to start in each of the months from the period Sep 89-Jul 90, for different parameters of the model.
- We search through all possible parameters and find the “best” set which maximizes the probability of a recession to start in July 1990 and minimizes that probability for earlier periods.

Testing: Late 2000s recession



- At this stage the goal is to test the model with parameters found at the training stage.
- We analyze the data from the periods preceding and coinciding with the late 2000s recession (Dec 2007-Jun 2009).
- We use the model to assess the probability of a recession to start in December 2007.



The probability of a recession to start in a given month. The horizontal axis represents the future (Jul 2007-Feb 2009), the vertical axis corresponds to the current month.

- We show that the probability grows steadily starting from Jan 2007 and reaches 1 in Nov 2007.
- Thus, our binary stochastic model, based on analysis of data preceding two previous recessions, demonstrates an ability to register early-warning signals for the late 2000s recession.