

# Kohonen Maps and TS Algorithms

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## INTRODUCTION

In the analysis of a temporal process, Kohonen maps may be used together with time-series (TS) algorithms. Previous research aimed at combining Kohonen algorithms and Markov switching models in order to suggest a periodization of the international bimetalism in the 19<sup>th</sup> century (Boyer-Xambeu, Deleplace, Gaubert, Gillard and Olteanu, 2006). This research was based on an economic study of the international monetary system ruling at this time in Europe, which combined three monetary zones: a gold-standard one, centred in London, a bimetallic one, centred in Paris, and a silver-standard one, centred in Hamburg (Boyer-Xambeu, Deleplace and Gillard, 2006). The three major financial centres of that system (London, Paris, and Hamburg, hence the label LPH used hereafter) were linked through arbitrage operations between markets for gold and silver and markets for foreign exchange located in those centres. Since two metals, gold and silver, acted as monetary standards in that system, it worked as an international bimetallism. Its growing integration during half a century (from 1821 to 1873) was reflected in the convergence of the observed levels of the relative price of gold to silver in London, Paris, and Hamburg. However, this integration process was subject to various changes, which can be understood as exogenous shocks disturbing that process.

One such shock is vastly documented in the literature: the discovery of new gold mines in the United States and Australia, which led to a sudden decline in 1850 of the gold-silver price over all the markets in the world. This decline was not of the same magnitude everywhere, and therefore the spread between the London, Paris, and Hamburg gold-silver prices increased, stopping for a time the integration process of the system. This is what we will call a breaking in that process. The present paper aims at locating the major breakings occurring during the period of international bimetallism; a historical study could link them to special events, which operated as exogenous shocks on that system. The indicator of integration used is the spread between the highest and the lowest among the London, Paris, and Hamburg gold-silver prices.

Three algorithms are combined to study this integration: a periodization obtained with the SOM algorithm is confronted to the estimation of a two-regime Markov switching model, in order to give an interpretation of the changes of regime; at the same time change-points are identified over the whole period providing a more precise interpretation of these varying types of regulation.

Section 2 summarizes the results obtained with the SOM algorithm to differentiate the sub-periods obtained using the whole available data.

Section 3 presents the kind of model used and the results of its estimation using the new indicator, the

spread computed at each period of quotation between the three relative prices of gold in silver. The sub-periods are confronted to the two regimes obtained and some evidence of a relation between the regime and the volatility of the spread is presented.

Section 4 presents the technique used to identify change-points in the temporal process and some strong results of breaks in mean and in variance of the spread are obtained. They are interpreted in terms of monetary history as, for some of them, they are quite new in the literature of this domain.

Some further directions of research are indicated in conclusion.

## THE SUB-PERIODS OBTAINED WITH A SOM ALGORITHM<sup>1</sup>

### The Data

The relative prices of gold in silver are computed from the price of each metal observed, twice a week, in each of the three financial places, Paris, London and Hamburg (respectively, *poa*, *lgs*, and *hoa*), from the beginning of 1821 until the end of 1860. The same type of data is available for the exchange rates (Pound in Francs, Pound in Marks, Mark in Francs: respectively, *lpv*, *hlv*, and *phv*).

An observation is a set of twelve values, two quotations (Tuesday and Friday) for each of the six variables.

A computed variable has been added to emphasize the relation between the relative price of metals in Hamburg and the average level in Paris and London of this value (*hpl*).

Most of the time the quotations show rather small differences within a given week, but periods with important troubles, Paris in the late 1840s for instance, may be well separated from the more classical ones.

After the Kohonen classification using a grid of 25 nodes, a hierarchical ascending classification is used to produce a small number of macro classes, in this case 6 macro classes, corresponding to the main sub-periods. This latter classification is constructed with the code vectors obtained from the first process<sup>2</sup>.

## Characteristics of the Macro-Classes

Large sequences of contiguous weeks are grouped in the macro-classes, however a few years are fragmented in short periods situated in different classes

- Class 1 is constituted of 3 groups of years 1829-30, 1834-38, 1848-49 and a lot of fragments of other years
- Class 2 is more simple to describe with 3 intervals 1832-33, 1842-43 and 1846-47 and some sparse weeks from the 1830s.

They represent a central position contrasting to the well identified other classes:

- Class 3: 2 sets constituted of years 1824-25 and 1827-28, with almost no missing weeks in these intervals, indicating that this sub-period is very homogeneous
- Class 4: the end of year 1853 and the whole period 1854-60; again only a small number of weeks are missing for this continuous sub-period of more than seven years
- Class 5: 1821-24 and 1826-beginning 1827 plus small parts of 1830 and 1832
- Class 6: two sets 1839-41 and 1851-53

The means of the variables used to obtain the classification can be represented to illustrate the great differences appearing between the sub-periods. Changing hierarchies between the relative prices are the characteristic identifying the four last macro-classes.

Rearranging the various classes according to calendar time allows to distinguish between three sub-periods: a) the 1820s (classes 5 and 3, covering 1821 to 1828); b) the 1830s and 1840s (classes 1 and 2, covering 1829 to 1849); c) the 1850s (classes 6 and 4, covering 1851 to 1860).

Only the years 1839-41 resist to that rearrangement, since they belong to class 6, while they should appear in classes 1 and 2 relative to the 1830s and 1840s; some explanation will be suggested in the last section.

Fig. 1. exhibits two contrasted situations, where the gold-silver price is respectively low (class 4) and high (class 5) in all the three financial centres. Fig. 2. confirms that opposition, since the two classes are also

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