A predicting indicator for exchange rate instabilities: a popular view.

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Introduction

In a former article [1] we have argued that Fourier analysis may be a valuable tool for the diagnostics of an exchange market. When a country has a shortage of export with respect to the import, it needs a flow of incoming foreign money to pay for the feast. The country attracts an incoming flow of investments. As foreign investors lose confidence however, they will retire. Then the foreign money becomes rare, and consequently expensive. The home currency devaluates. Next the foreign investors lose a part of their invested value and they will flee. This is the classical receipt for an exchange rate crisis.

A government that wants to avoid a crisis will take its measures long before a possible collapse. Then an indicator may be useful that yields a number for the stability of the exchange market, so that the risk of a collapse may be seen in an early stage. We have proposed to use the Fourier spectrum of the free market capital flow as a diagnostic tool. Because the mathematics will be accessible only for a limited public, we will try to explain the essentials of the method in a popular way. With a popular description a broader circle of people may be able to understand the essentials.

Dynamic systems

Suppose that a nursery teacher builds a tower with a little child. She piles up simple wooden blocks. From the air or the floor there come tremblings. The tower will oscillate a little bit. It is essentially a dynamic system that responds on external influences. As the tower becomes higher, the oscillation becomes slower and slower. At a certain point the situation becomes critical: the oscillation stops and the whole tower turns aside. It falls down. What may we learn from this example?

A dynamic system may react on external influences in a stable way, or in an unstable way. When it becomes unstable, a disruption will follow. In the oscillation behavior of the system one may see how far there exists the risk of a collapse.

Stability requires that disturbances extinguish

We consider a second example of a dynamic system, a car with defect shock absorbers. If one pushes several times upon a car, it will oscillate a little bit. When the shock absorbers are all right, the oscillation will damp out immediately. But when the absorbers are defect, the oscillation will damp out slowly. The oscillation takes a long time to extinguish. When one drives with such a car along a bumpy country road, it may be difficult to keep it under control.

A rapid damping of disturbances causes a stable behavior. A defect damping causes a long time for disturbances to extinguish. When disturbances do not damp at all, the whole system may become unstable.

Which kind of exchange markets do we want to have?

An exchange market may be seen as a dynamic system. Sometimes there are disruptions. Then crises occur with major consequences for capital markets, investments and so on. No reasonable man will wish an exchange market to become unstable. Therefore an exchange market should exhibit a stable dynamic behavior. Small disturbances should not lead to major disruptions. Disturbances should extinguish rapidly. Every disturbance should vanish in a sufficiently short time.

A diagnostic tool

Amply before a crash one would like to see how far a market is stable or unstable. So a diagnostic tool is desirable to conclude from the oscillation behavior how far there is the risk of an unstable system. As an analogous tool we may consider the frequency display of an electronic audio amplifier. An audio signal is a composition of bass tones, middle frequency sound and high frequency tones. The slow oscillation of a double-bass causes a low frequency tone. The more rapid oscillation of a cello makes a middle frequency tone. The very rapid oscillation of a violin is experienced as a sharp and high tone. With the aid of a frequency display one may see the different frequencies separately. The low frequency channel shows the bass tones, the middle frequency channel shows the middle tones and the high frequencies are displayed by the high frequency channel. In the same way there exists a mathematical tool that analyses a time series into its composing frequencies. This is called a Fourier transform. The Fourier transform acts as a frequency display: it separates slow oscillations from more rapid oscillations. By a Fourier transform one sees how far the time series is composed of slow or rapid oscillations.

If one would make a Fourier transform of the oscillation of the wooden tower, one would see that the frequency of the oscillation becomes lower as the tower becomes higher. In the same way one may analyze the oscillation of a car with defect absorbers. One will see a sharp peak on the frequency display, which means that there is a well defined and long lasting oscillation. When the absorbers are all right, the peak on the frequency display will be less sharp.

In the same way one may observe the frequency display, the Fourier spectrum, of an exchange market. A sharp peak corresponds with a lack of damping and the risk of a collapse. A wide spectrum indicates that the damping of shocks is normal and that the market is stable. Then the risk of a collapse is small.

Conclusion

Fourier transforms may be a useful tool for the study of exchange markets. They may yield an indicator for the stability of the capital flows, which behave as a dynamic system. The Fourier transform analyses the frequency properties of the capital flows. It may serve as an indicator for the stability of the market.

J.M.M.J. Vogels, Eindhoven, The Netherlands (2008).

[1] A predicting indicator for exchange rate instabilities. J.M.M.J. Vogels, Eindhoven, The Netherlands (2008). See on www.essentiae.nl

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Some basic mathematics

An exchange market may be seen as a dynamic system. Every day it is disturbed by all kinds of messages, news, rumors. These cause fluctuations y in the capital flows by the free market. After each new fact the market sees the ideal value of y as u. The deviation between the ideal and the actual value of the capital flow fluctuation is (u-y). The market follows the ideal with a time-derivative of y, in $dy/dt \sim (u-y)$. The velocity of change of y is proportional to the deviation (u-y). So

$dy/dt = p\ (u-y)$.

Suppose that a fly walks over a computer screen horizontally with some random velocity. Its position is u. With the mouse and cursor at position y we try to follow it.

We see the deviation (u-y) and give the cursor a velocity dy/dt that is proportional to the deviation. The constant p is a real number. The problem described is a feedback system: the reaction dy/dt is adjusted on the basis of the observation of (u-y). In the same way as the walking fly disturbs our distance, the financial market is a system that is disturbed day after day by economic messages, by political news, by rumors and so on.

It is easy to verify that a value $p < 0$ describes an instability. If then $u = 0$, the fluctuation y grows to infinity: $y \sim \exp (-p . t)$. A value $p > 0$ is stable. The value $p = 0$ marks the stability limit. There the system does not follow the disturbances, as $dy/dt = 0$.

The constant p has the dimension of a frequency [1 / time] . It is the characteristic frequency by which the system is able to follow disturbances. If a disturbance u has a frequency $f >> p$, the system is too slow to follow it. So high frequencies will not be present in y. If a disturbance has a frequency $f << p$ however, the system follows it fully. The system adapts completely to low frequency disturbances. Now suppose that disturbances behave as white noise, like the noise of a radio. White noise contains all frequencies. The system can only follow frequencies below p. On a frequency display (Fourier transform) one sees a spectrum with a width of nearly p . The width of the spectrum shows the magnitude of p .

When $p = 0$ the system becomes unstable, so the desired situation is a large value of p . The best situation is therefore a wide spectrum. Then the system is far from instability. The hypothesis now is that the width of the spectrum of the capital flows may serve as an indicator for the stability of the market. When the spectrum becomes unusually narrow, that may be a warning for instability that may come.

If the method turns out to work well, it may be tested for other kinds of economic instabilities. The dynamic system approach may be useful for other problems, as the assuptions made are so general.

(extension 2012, J.M.M.J. Vogels)