Directional Changes, Definitions

Edward Tsang

Working Paper WP050-10

Centre for Computational Finance and Economic Agents (CCFEA), University of Essex

Revised 1 December 2010

I. Definitions of Directional Change Events

A **Directional Change Event** can be a **Downturn Event** or an **Upturn Event**.

A **Downward Run** is a period between a Downturn Event and the next Upturn Event. An **Upward Run** is a period between an Upturn Event and the next Downturn Event.

In a Downward Run, a **Last Low** is constantly updated to the minimum of (a) the current price and (b) the Last Low. In an Upward Run, a **Last High** is constantly updated to the maximum of (a) the current price and (b) the Last High.

In a Downward Run, given a Threshold (a percentage), an **Upturn Event** is an event when the price is higher than the Last Low by the Threshold. An Upturn Event terminates a Downward Run, and starts an Upward Run.

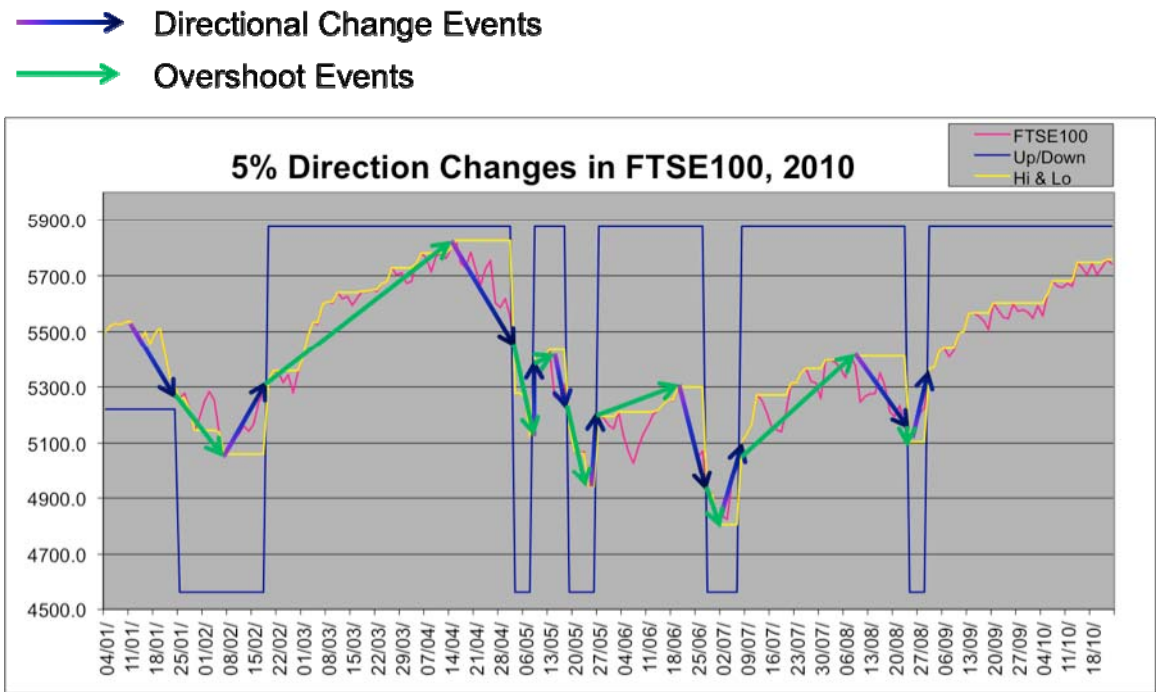
In an Upward Run, given a Threshold (a percentage), a **Downturn Event** is an event when the price is lower than the Last High by the Threshold. A Downturn Event terminates an Upward Run, and starts a Downward Run.

The above definitions are mutual recursive. Operationally, we set both the Last High and Last Low to the price at the beginning of the sequence.

A Downturn Event is followed by a **Downward Overshoot Event**, which is ended by the next Upturn Event, which is itself followed by an **Upward Overshoot Event**, which is ended by the next Downturn Event. So time is defined by sequences of event cycles of four events, as shown in Figure 1.

… → Downturn Event →
Downward Overshoot Event →
Upturn Event →
Upward Overshoot Event →
Downturn Event → …

Figure 1: Directional Changes in FTSE100



II. Time Ontology

What is time exactly? The most studied ontology were mainly based on **point**, **intervals** and **events** (Benthem 1983). Most people in finance are familiar with a point-based analysis. For example, people talk about the price or a commodity at a certain time (e.g. 1:23pm) on a certain day. In directional change research, we have adopted the event ontology. Under this ontology, time is defined by events. (In other words, if there is no event, there is no time.)

A directional change event is a primary object in an event-based system. If one wants to see a directional change event in the light of an interval-based system, then we can say that this event takes place within an interval.

In physical time, which is popularly seen in a point-based system, an interval is a continuous set of points. In a point-based system, a Downturn Event can be seen as a process that occupies an interval. One can define the starting point of a Downturn Event as a **Downturn Point** and the end of a Downturn Event a **Downturn Confirmation Point**. The Downturn Point is the point at which the price last peaked. The Downturn Confirmation Point is the point at which the price has dropped by the threshold (percentage) from the Downturn Point. Similarly, one can define the start and end points of an Upturn Event as **Upturn Point** and **Upturn Confirmation Point**.

Under this stipulation, the **Downturn Event Interval** (**DEI**) is the set of all points between the Downturn Point and the Downturn Confirmation Point. (Here one can debate whether the interval should or should not include the Downturn Confirmation Point; we adopt the latter in our formal definition below.) The **Upturn Event Interval** (**UEI**) is the set of all points between the Upturn Point and the Upturn Confirmation Point. Formally they are defined as follows:

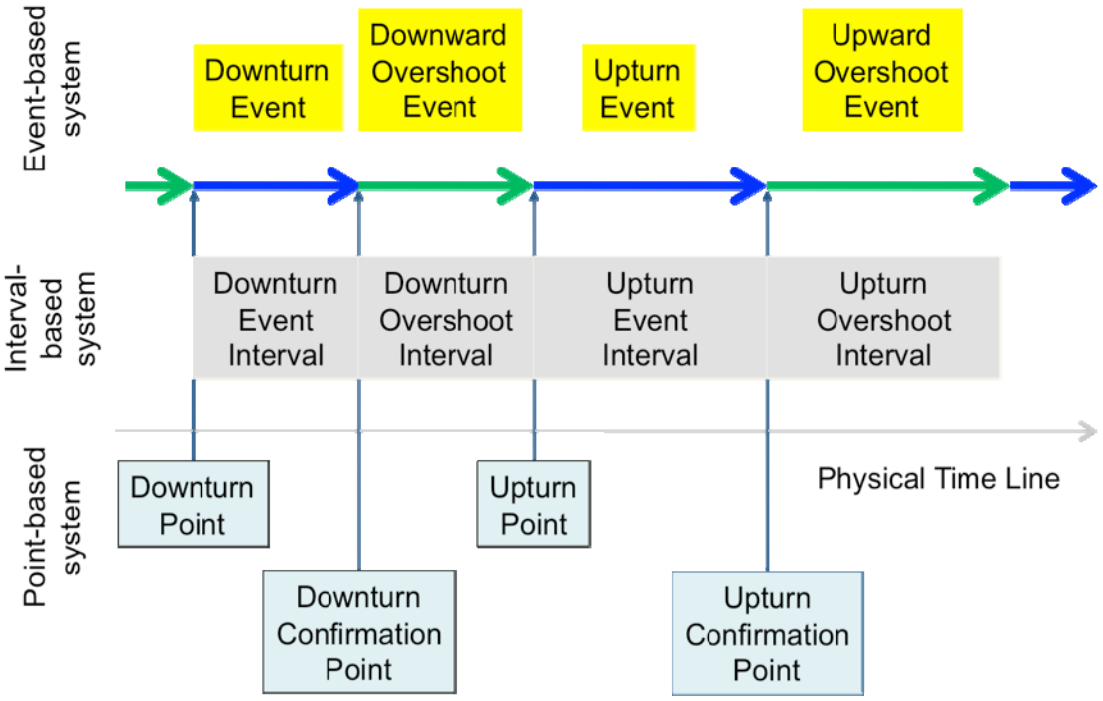
$$DEI =_{def} \{t \mid \text{Downturn Point} \leq t < \text{Downturn Confirmation Point}\}$$
$$UEI =_{def} \{t \mid \text{Upturn Point} \leq t < \text{Upturn Confirmation Point}\}$$

The Downward Overshooting Event is a process that occupies an interval, which we refer to as the **Downward Overshooting Interval** (**DOI**), which is the set of all points between the previous Downturn Confirmation Point and the next Upturn Point. Similarly, an **Upward Overshooting Interval** (**UOI**) is the set of all points between the previous Upturn Confirmation Point and the next Downturn Point:

$$DOI =_{def} \{t \mid \text{Previous Downturn Confirmation Point} \leq t < \text{Next Upturn Point}\}$$
$$UOI =_{def} \{t \mid \text{Previous Upturn Confirmation Point} \leq t < \text{Next Downturn Point}\}$$

The relationship between our event-based system and the point-based system is shown in Figure 2. For a full account of time ontology, and relationship between different time systems, readers are referred to Van Benthem (1983).

Figure 2: Summary of terminology and relating events to points



III. Ex-Ante and Post-Ante views under different systems

It is worth noting that in the point based system, at the Downturn Point, we do not know that a Downturn Event has started. We would only know that a Downturn Event has happened at the Downturn Confirmation Point. Similarly, we only know that a Upturn Events has happened at the Upturn Confirmation Point.

According to our definition, Overshooting Events are events in between Directional Change Events. For that reason, as soon as a Downturn Event is confirmed, we know that a Downward Overshoot Event has started. However, we will not know when it ends until the next Upturn Event is confirmed. This means an Upturn Confirmation Point does not only confirm an Upturn Event, it also confirms the end the last Upturn Point, which is the end of the last Downturn Overshoot Event. The ex-ante and post-ante views are summarized in Table 1.

In the event-based system, events are primary objects. Therefore, one normally discusses

events without referring to the start and end of events. One could, if one wishes to, break events down into sub-events.

Events	**Points**	**Post-ante view**	**An-ante confirmation views**
Downturn Event	Start	Downturn Point	Downturn Confirmation Point
	End	Downturn Confirmation Point	Downturn Confirmation Point
Downturn Overshoot Event	Start	Downturn Confirmation Point	Last Downturn Confirmation Point
	End	Next Upturn Point	Next Upturn Confirmation Point

Table 1 – Summary of different views for different events (views on Upturn and Upturn Overshoot Events are similar and omitted here)

Acknowledgements:

The Directional Change and overshooting concepts come from Professor Richard Olsen and his team (Glattfelder et al, forthcoming). This paper has benefited from inputs from Richard Olsen, Alex Dupuis, Wing Lon Ng, Iacopo Giampaoli, Shaimaa Masri and Monira Al-Oud.

Bibliography

[1] Glattfelder, J.B., Dupuis, A. & Olsen, R., Patterns in high-frequency FX data: discovery of 12 empirical scaling laws, Quantitative Finance, forthcoming (earlier version: An extensive set of scaling laws and the FX coastline, Working Paper WP025-08, Centre for Computational Finance and Economic Agents (CCFEA), University of Essex, September 2008)

[2] Van Benthem, J., The logic of time, D Reidel Publishing Co, 1983