

2026 Philippine Statistical Association Inc (PSAI)

Visualizing Reorganization in Financial Market Momentum through Phase-space Reconstruction

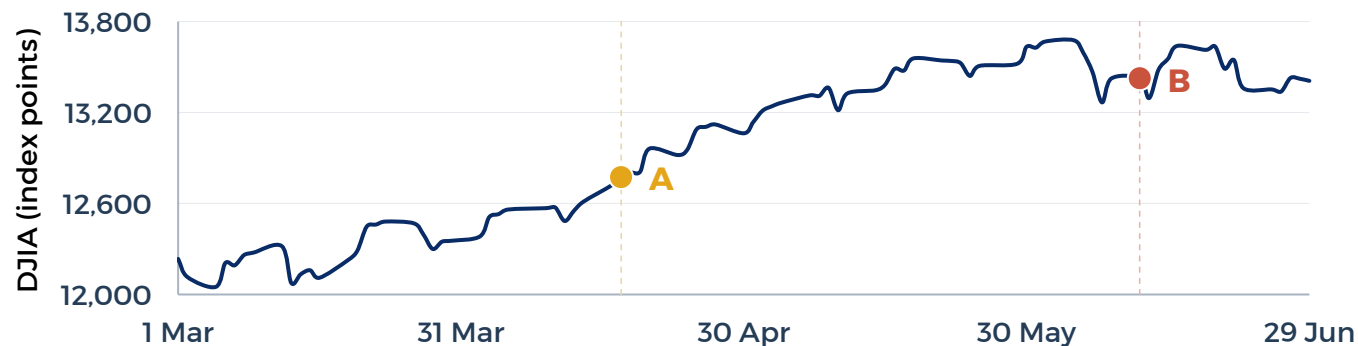
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Bangko Sentral ng Pilipinas

The views expressed in this paper are those of the authors and should not be interpreted as reflecting the views of the BSP.

The same reading can tell two different stories

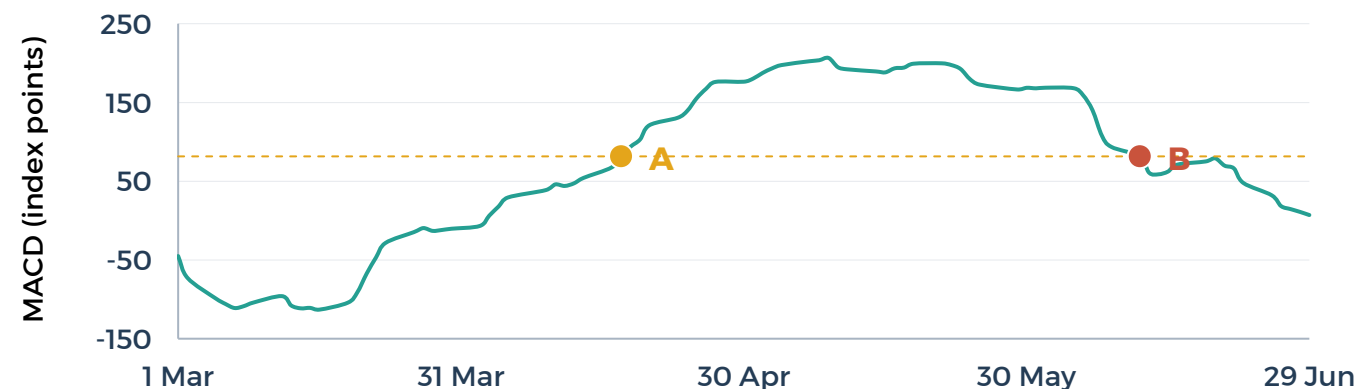
DJIA: 1 March-29 June 2007



A and B both round to MACD = 81.5.

At A, momentum is building. At B, it is fading.

Nearby readings show whether momentum is rising or falling.



A 17 Apr: 81.5, rising

B 11 Jun: 81.5, falling

Problem

A single MACD reading leaves its surrounding sequence unseen.

Research question and objective

RESEARCH QUESTION

How does the organization of market momentum differ across reference, crisis-containing, and recent periods?

RESEARCH OBJECTIVE

Examine how momentum patterns recur or reorganize across these periods, and what those changes may contribute to systemic-risk monitoring.

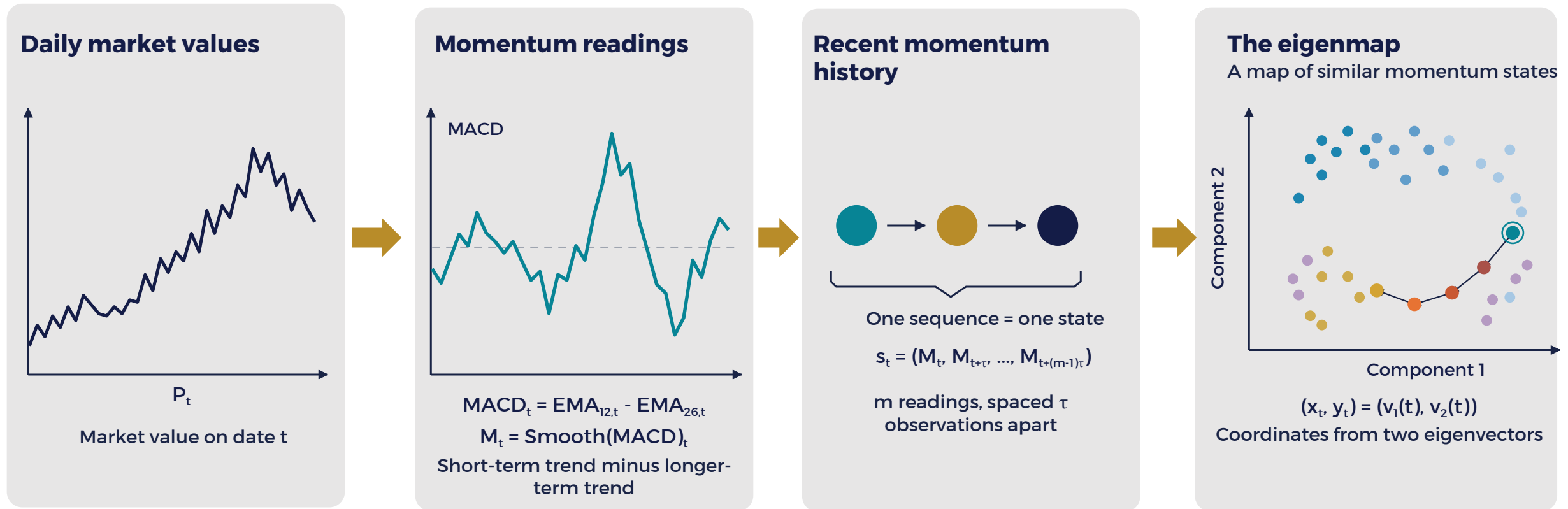
Two historical crises and today's Philippine market

Application	Series	Window	Role
Global Financial Crisis	DJIA	1 Aug 2006 – 1 Nov 2007	Comparison
	DJIA	1 Nov 2007 – 30 Nov 2009	Crisis-containing
Asian Financial Crisis	USDPHP	1 Jan 1996 – 30 Jun 1997	Pre-AFC comparison
	USDPHP	1 Jan 1996 – 31 Dec 1998	Crisis-containing
Recent Philippine	PSEi	14 May 2024 – 14 May 2026	Recent
	USDPHP	14 May 2024 – 14 May 2026	Recent

From market data to momentum map

Each point represents a sequence of momentum readings, rather than a single market value.

Laplacian eigenmaps calculates coordinates that aim to keep similar neighboring sequences close together.

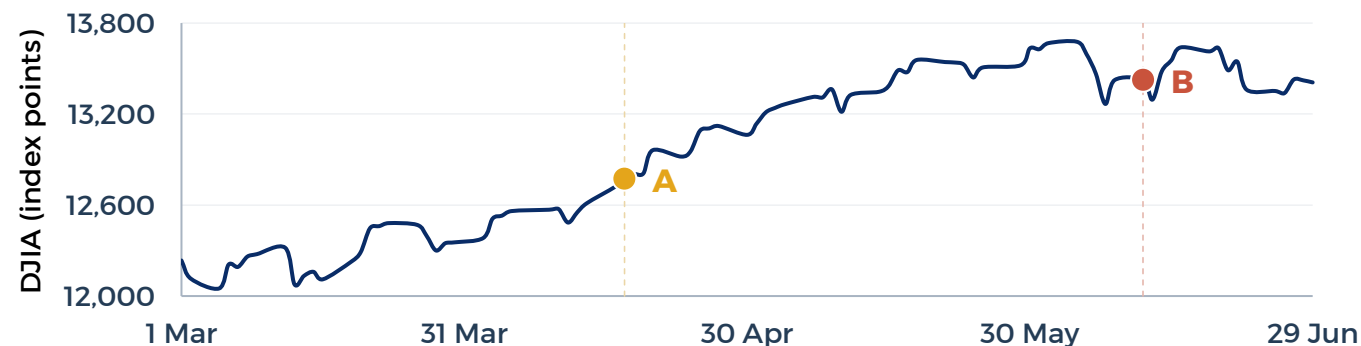


P: market value M: smoothed momentum τ : time lag m : number of readings v_1, v_2 : coordinate eigenvectors
Arrows between steps show processing order; arrows on the path show time order.

Eigenvectors provide the map coordinates; the connecting path follows time.

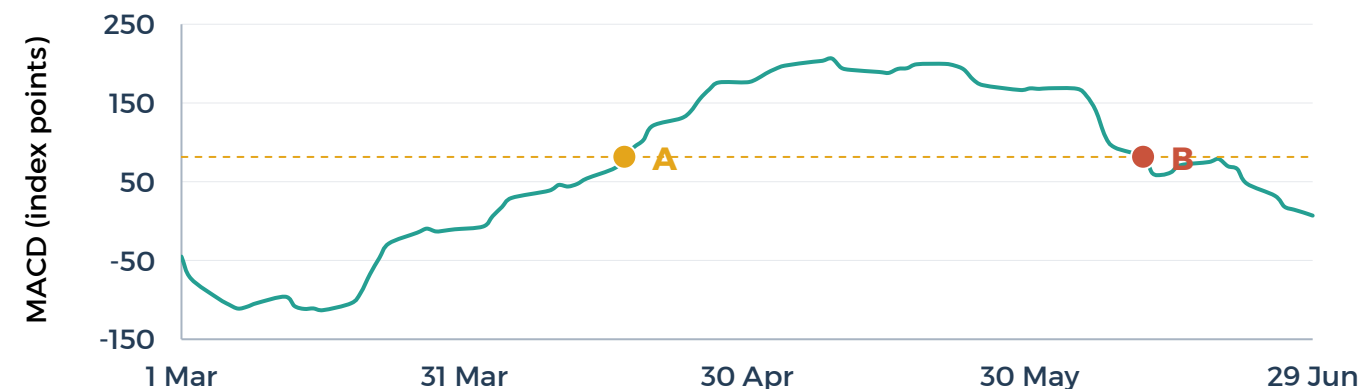
MACD: is the short run outrunning the long run?

DJIA: 1 March-29 June 2007



MACD above zero

The 12-observation EMA sits above the 26-observation EMA.



MACD below zero

The 12-observation EMA sits below the 26-observation EMA.



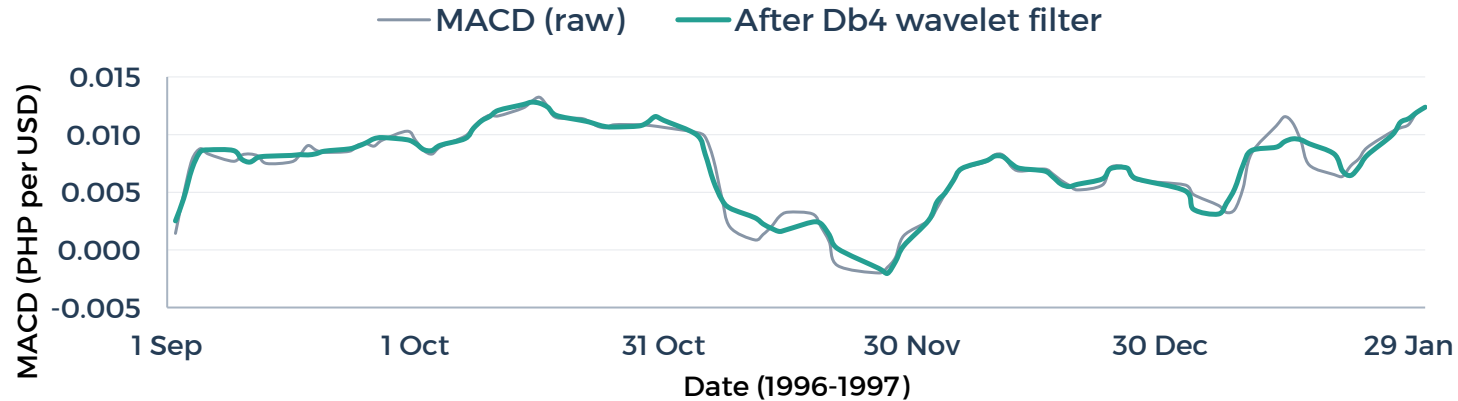
MACD changing

The gap is widening, narrowing, or changing sign. The same value can occur while momentum strengthens or weakens.

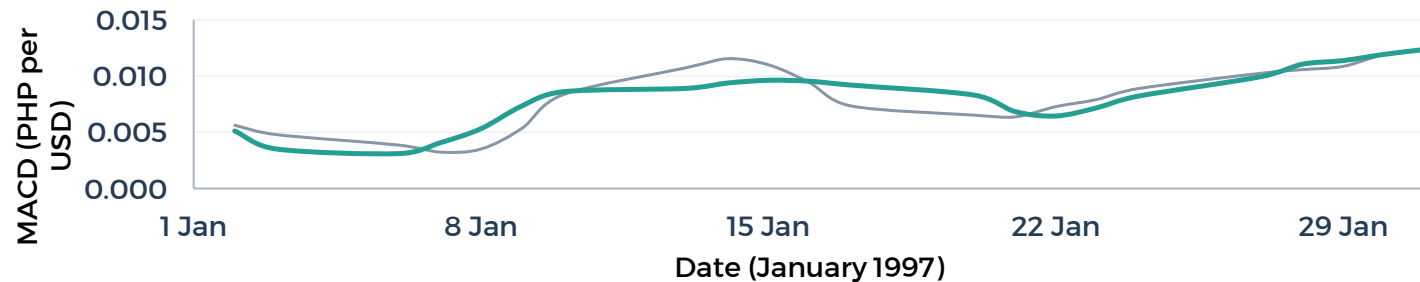
A 17 Apr: 81.5, rising

Wavelet filtering keeps the broader momentum pattern

USDPHP MACD: September 1996-January 1997



January 1997 close-up: raw and filtered momentum



Filtering softens brief changes while retaining the broader momentum pattern.

What we do

Decompose MACD with a Daubechies-4 (Db4) wavelet.

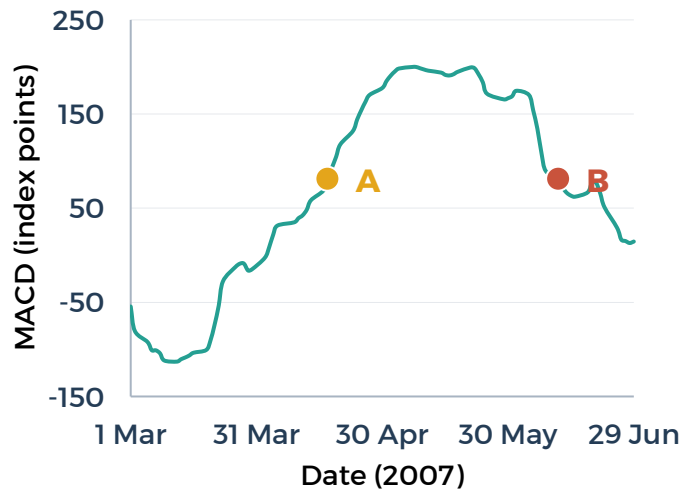
Set the detail coefficients at the two highest-frequency levels to zero, then rebuild the series.

Why

Rapid fluctuations would scatter the reconstructed states. Removing them brings the broader momentum sequence into view.

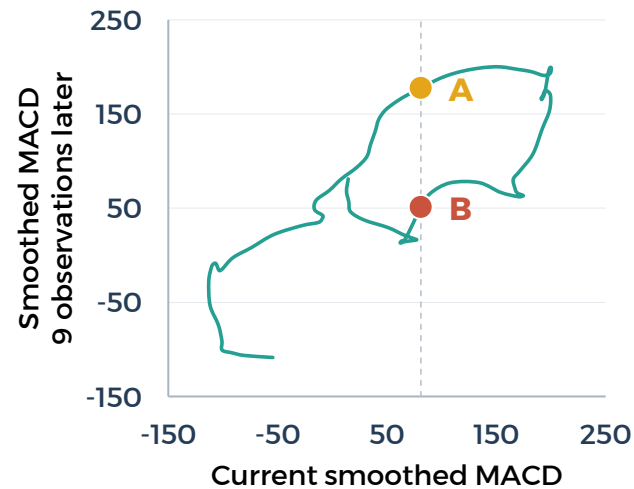
Delay embedding gives each reading its history

DJIA: March-June 2007



A: (81, 178) - strengthening

Two readings form one point



B: (81, 51) - weakening

$$X_t = [x_t, x_{t+\tau}, \dots, x_{t+(m-1)\tau}]$$

x_t : one smoothed MACD reading at observation t .

X_t : one state containing m readings, spaced τ observations apart.

One reading gives the level; the sequence gives its context.

τ time delay

Spacing between the readings in a state. Chosen as the first local minimum of average mutual information, searched over 1 to 100 days.

m embedding dimension

The minimum number of readings needed to get a clear picture of the trajectory: where false nearest neighbours stop falling.

m is not the number of plot dimensions. The map in Step 4 is drawn separately in 2D and 3D.

How to read a momentum map

Laplacian eigenmaps (Belkin and Niyogi, 2003) link nearby reconstructed momentum states and place them close together in two or three dimensions, preserving local neighbourhoods.



Each point

One reconstructed state: a short sequence of momentum readings.



Connecting lines

Join states in chronological order, tracing how momentum evolves.



Colour

Marks the date. Labels on the colour bar give approximate timing.



The axes

Eigenmap coordinates. Not prices, returns, MACD values, or calendar time.



A loop

Momentum returns along a familiar route: strengthen, moderate, reverse, recover.



Branches and sharp turns

Momentum follows a different route: reorganization.

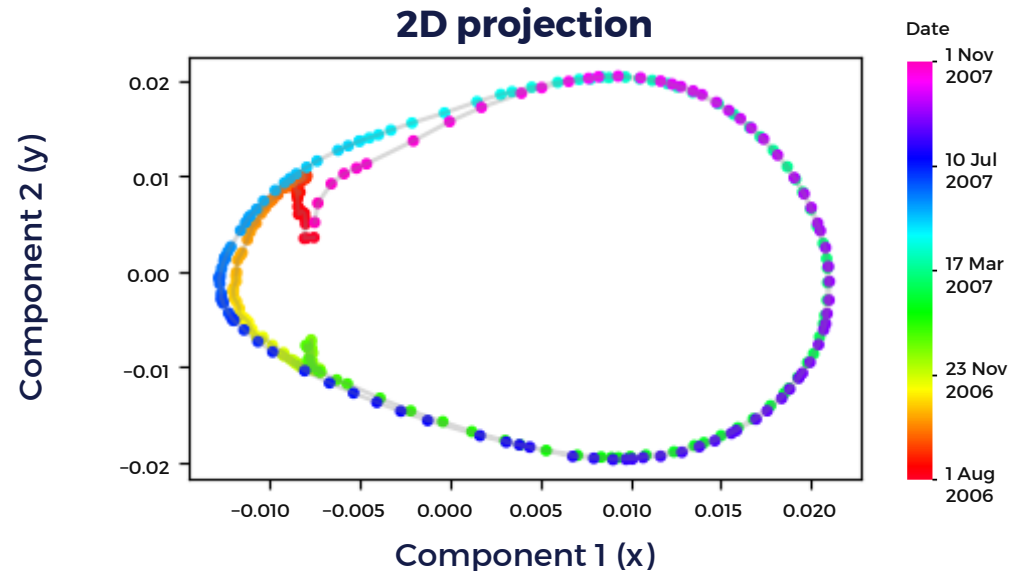
Each window has its own map. Compare shapes, loops and branches, not positions, orientations or axis scales.

DJIA Around the Global Financial Crisis

The rounded comparison route becomes more angular and differentiated in the GFC window.

Earlier comparison window

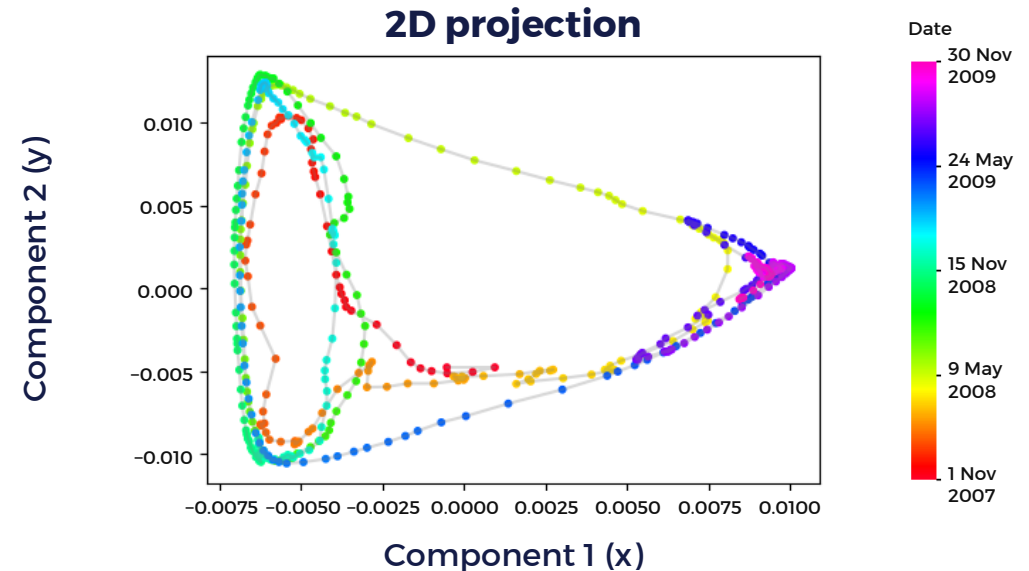
1 August 2006–1 November 2007



Momentum appears to build and unwind through **familiar stages** as the market alternates between advances and corrections. Advances and corrections appear to follow similar momentum sequences.

Global Financial Crisis window

1 November 2007–30 November 2009



Sharper turns and interior paths create a wedge-like pattern. The decline and recovery appear to follow different sequences of momentum states.

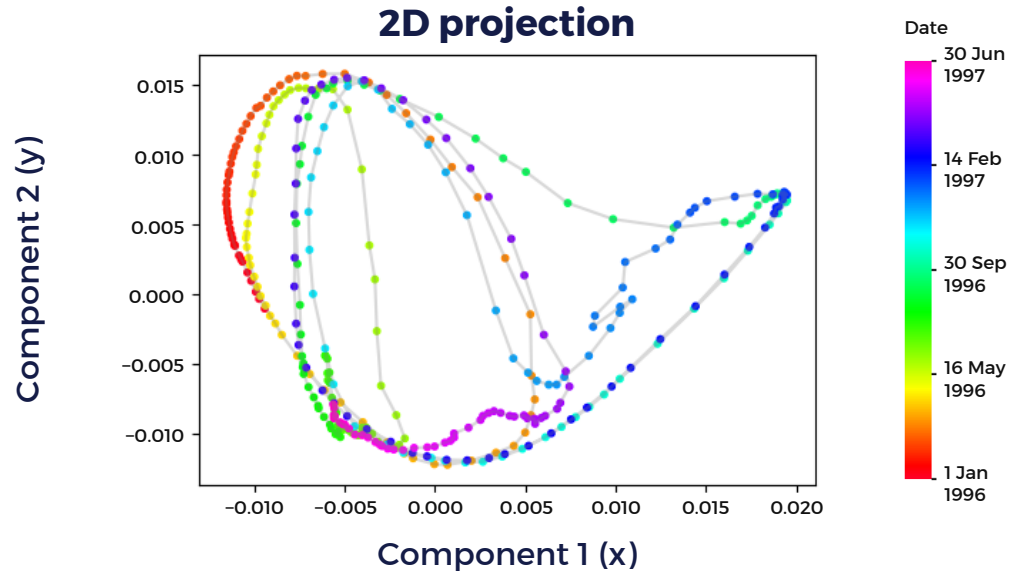
This suggests more **disruptive repricing**, with recovery following a different momentum sequence from the decline.

USDPHP Around the Asian Financial Crisis

The extended window shows how the pattern reorganizes when the crisis period is included.

Pre-AFC comparison window

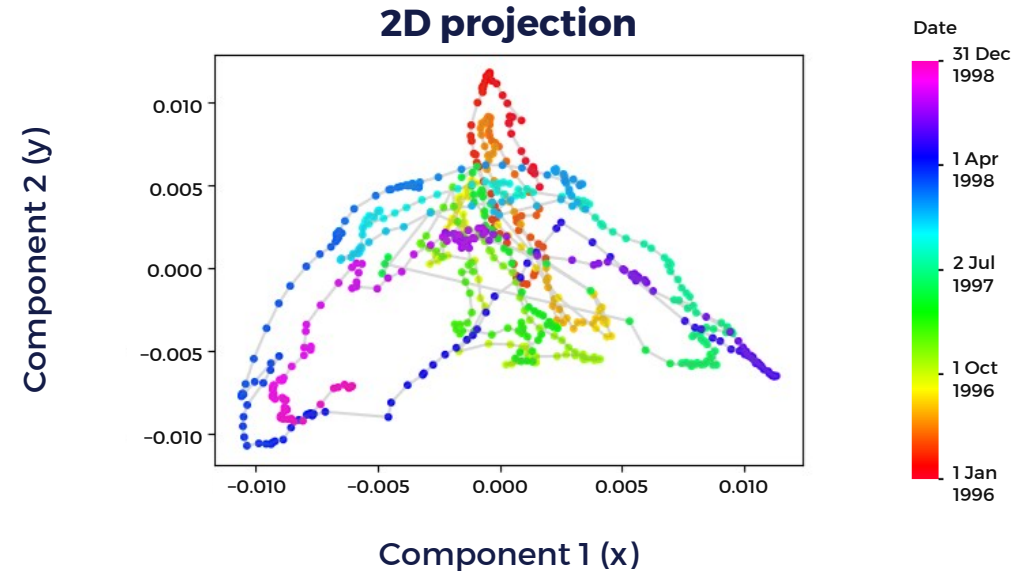
1 January 1996–30 June 1997



The broad curved route has several nearby passages. This suggests that peso-dollar momentum builds and unwinds through **broadly similar stages**.

AFC-containing window

1 January 1996–31 December 1998

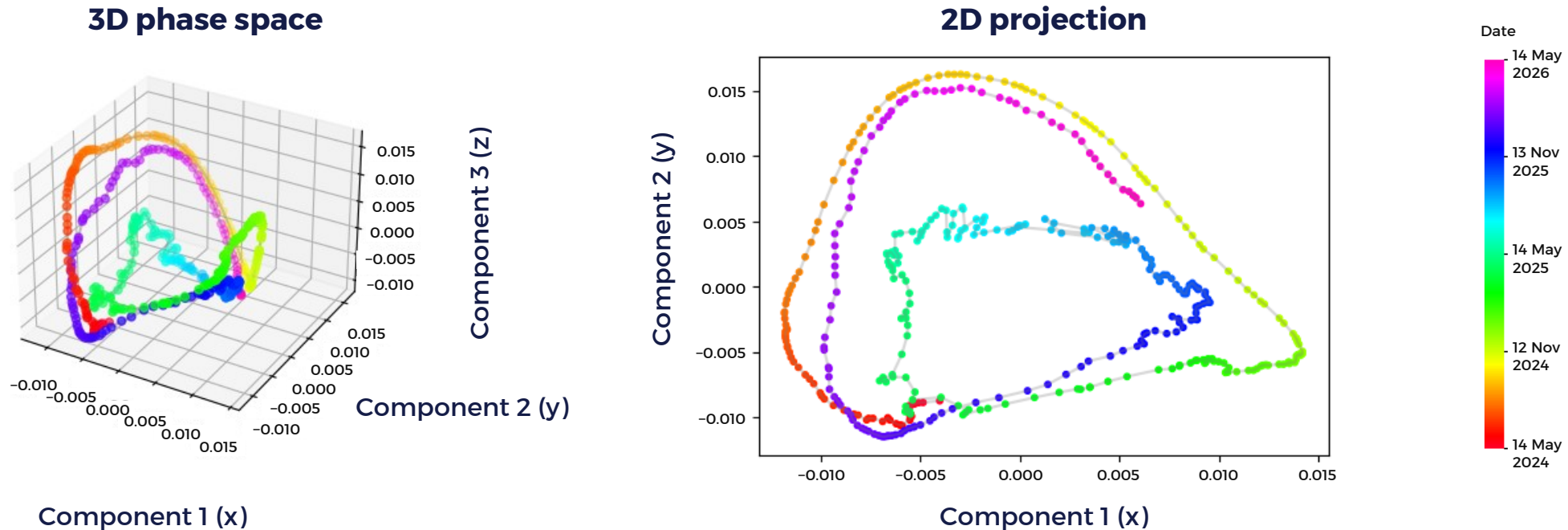


The trajectory clusters near the center, then separates into distinct branches. This suggests that similar recent momentum patterns are followed by **different sequences of strengthening and weakening** during the extended crisis-containing period.

Recent PSEi: Outer and Interior Momentum Routes

The outer loop and interior route form a recognizable pattern with different adjustment paths.

14 May 2024–14 May 2026



The broad outer loop and compact interior route reconnect near the lower part of the pattern. Together, they show related momentum states reached through different sequences.

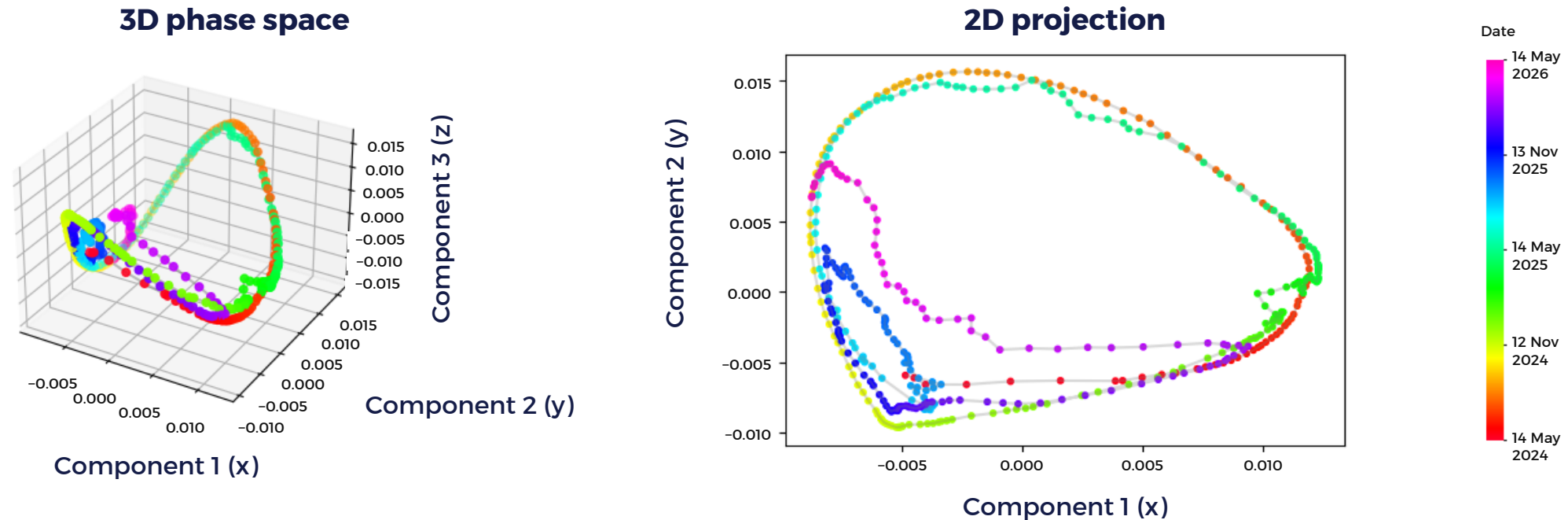
The overall structure **remains recognizable** despite variation within it. The comparison concerns momentum organization, rather than the size of price movements.

Economically, equity-market momentum can develop differently from one episode to another while returning to related conditions. Compared with the historical crisis examples, **this recent pattern retains a more recognizable overall organization.**

Recent USDPHP: Recurring Exchange-Rate Adjustment

A broad outer loop persists while alternative paths pass through the left and lower interior.

14 May 2024–14 May 2026



The nearby outer passages suggest that momentum returns to related reconstructed states. Interior routes show that some states are reached through different sequences.

Compared with the AFC-containing figure, the recent trajectory retains a more continuous outer outline. The 3D view also separates paths that appear close in the projection.

Economically, the recurring loop is **consistent with exchange-rate momentum strengthening, moderating, and reversing through broadly familiar stages**. The interior departures suggest that individual episodes can take a different course within that recurring pattern.

What this adds to surveillance – and where it goes next

One visual framework, three clear takeaways.

1 What it adds

Turning-point context: Places a possible shift in market adjustment within the trajectory leading into and out of it.

Recurring or altered routes: Shows whether similar sequences return or branch into a different course

2 What it does not establish

Not an automatic turning-point detector: Confirm candidate shifts against the dated MACD and market series.

Not a standalone systemic-risk signal: The map does not establish the cause or significance of a shift.

3 Where the research goes next

Test robustness: Use rolling windows and alternative preprocessing, embedding and eigenmap settings.

Add quantitative validation: Consider recurrence measures, Poincaré sections and Lyapunov estimates, with robustness and surrogate-data tests.

SURVEILLANCE TAKEAWAY

Use recurring routes as a visual reference; investigate departures alongside prices, returns, volatility, liquidity conditions and market events.

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