Tracking Lexical Semantic Change with a Three-Level Network

Evidence from Japanese Economic News during Japan's "Lost Decade" (1990–2000)

バブル経済　価格破壊　景気

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The Interpretability–Aggregation Gap

Existing approaches either sacrifice interpretability for comparability or maintain interpretability but lack a principled macro-level summary that does not create a new black box, and in both cases, an operational bridge to multilevel discourse theory is missing.

Embedding-Distance Approaches

- Comparable — easy to rank across terms/time
- Difficult to explain — a single displacement score
- May conflate genuine dynamics with sampling artefacts

Interpretable Alternatives

- Decompose change into meaningful facets (sentiment, breadth, intensity)
- No principled macro-level summary without a new black box
- Relative contribution of each dimension underspecified

What is needed is an interpretable measure of lexical semantic change that is both decomposable and aggregable.

Data and Research Design

A controlled comparison: two metaphorical crisis terms and one conventional term.

Corpus: Nikkei Telecom (日経テレコン) **; Time period:** 1990–2000 (Japan's "Lost Decade")

バブル経済

conventionalised bubble metaphor

[ba.bɯ.ɾɯ keːzai]

Bubble economy

Boom–bust dynamics framed as an inflating-and-bursting entity.

価格破壊

damaged/destroyed object

[ka.ka.kɯ ha.kai]

Price destruction

Price competition is construed as physical damage to structures.

景気

[keːkʲi]

Business conditions

General economic conditions — a non-metaphorical baseline term.

A Three-Level Semantic Change Network

Semantic change is modelled across linked micro, meso, and macro levels.

MACRO

LSCI (Lexical Semantic Change Index)

PCA-based summary of year-on-year change magnitudes — comparable yet traceable.

MESO

Crisis Thematic Content

Proportion of crisis-lexicon evidence in local contexts — a domain-adaptable framing proxy.

MICRO

Sentiment · Breadth · Intensity

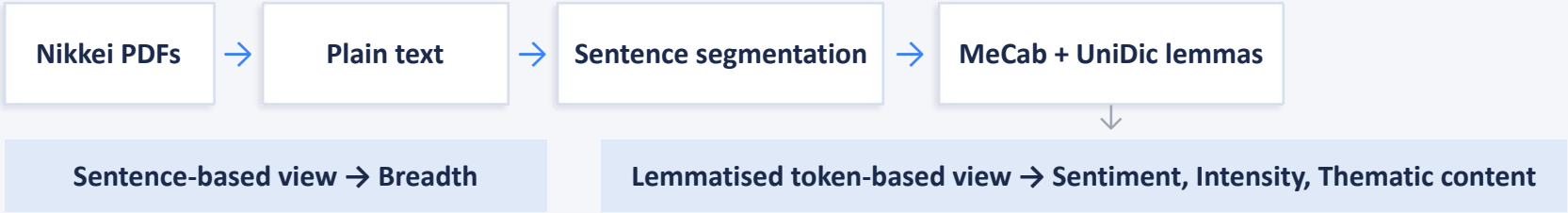
Connotative evaluation, contextual dispersion, and emotional arousal — interpretable aspects of usage change.

Frequency (salience) is retained as an auxiliary diagnostic, not a primary semantic driver.

From Corpus to Micro-Level Dimensions

Preprocessing produces two complementary views; three micro-level dimensions capture complementary facets of usage change.

Preprocessing



Sentiment

= polarity

Input: ±5 token collocates

JIWC affect lexicon
→ frequency-weighted mean

Breadth

= contextual dispersion

Input: Sentence embeddings

Sentence-BERT (50 sent. × 10 rep.)
→ mean pairwise cosine distance

Intensity

= arousal

Input: ±5 token collocates

JIWC × Warriner arousal norms
→ frequency-weighted mean

From Framing Proxy to Composite Change Signal

Crisis thematic content operationalises meso-level framing; the LSCI aggregates micro-level change via PCA.

MESO Crisis Thematic Content

→ For each target occurrence, scan the ±5 token collocate window
→ Count tokens matching the Economic Crisis Lexicon (21 lemmas)
→ Aggregate by year, normalise by total collocate tokens
→ Yearly index = proportion of crisis-lexicon evidence

Economic Crisis Lexicon： 不況，後退，恐慌，デフレ，崩壊，倒産，破綻，破産，不良債権，信用不安，損失，負債，赤字，失業，解雇，リストラ，無職，安売り，下がる，借金，物価高

MACRO Composite LSCI

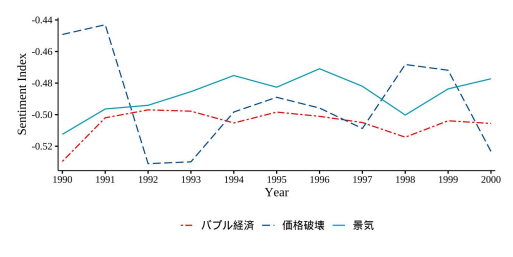
Yearly micro-level indices (sentiment, breadth, intensity)
→ Year-on-year absolute differences
→ Z-score standardisation
→ PCA: LSCI = weighted average of z-scored dimensions

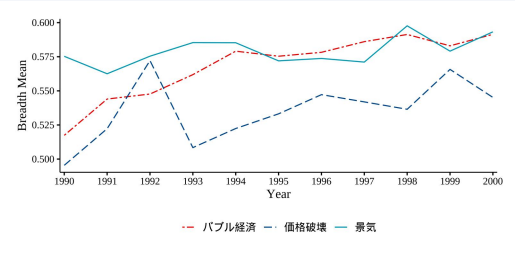
PC1 loadings → data-driven weighting
→ dimension attribution (which dimension drives change)

LSCI captures year-to-year change magnitudes, not raw semantic levels.

Frequency-based salience is retained as an auxiliary diagnostic of visibility and sampling stability, not a primary semantic driver (Dubossarsky et al., 2017).

Results I: Three Terms Show Distinct Multi-Level Profiles





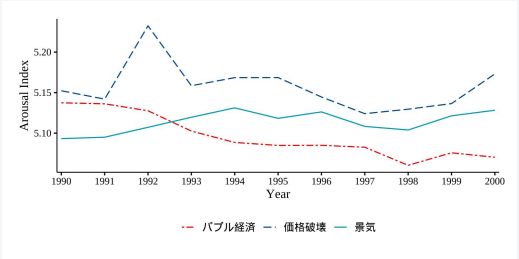


Figure 1: Micro-level dimensions change trajectories

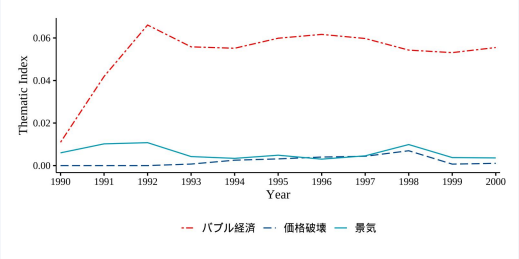


Figure 2: Meso-level dimensions change trajectories

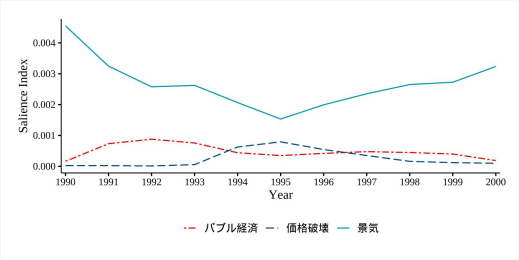


Figure 3: Frequency-based salience trajectories

バブル経済 combines sustained crisis embedding with expanding breadth; 景気 shows a prominent 1998 broadening alongside a local rise in crisis embedding; 価格破壊 exhibits late-emerging salience with a thematic peak in 1998 and heightened volatility.

Results II: LSCI — When Change Happens and What Drives It

LSCI summarises year-to-year change magnitudes; peaks indicate years of heightened reconfiguration in at least one micro-level dimension.

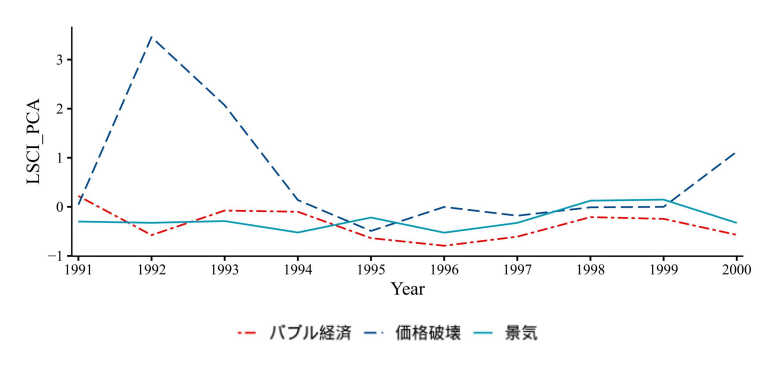


Figure 4: Macro-level change trajectories: PCA-weighted LSCI

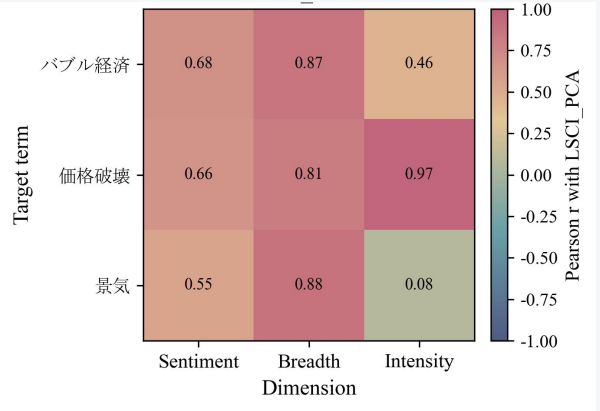


Figure 5: Correlations and z-scored dimension change magnitudes

バブル経済： Peak(1991); 価格破壊： Peak(1992–93 / 200); 景気： Peak(1998–1999).

バブル経済 and 景気: breadth-driven. 価格破壊: overwhelmingly intensity-aligned.

The same macro-level change pattern can be supported by different micro-level mechanisms — this is what makes a decomposable index analytically useful.

Discussion: Metaphorical Terms in Crisis Discourse

Compared with the conventional benchmark, metaphorical terms are more tightly coupled with crisis-oriented contexts and exhibit stronger affect-related reconfiguration — but via distinct pathways.

バブル経済

Stabilised period descriptor | **Breadth-led**

Persistently crisis-embedded while steadily broadening in contextual range — remains narratively anchored in downturn discourse throughout the decade.

価格破壊

Late crisis intensification | **Intensity-led**

Initially functions as a label for competitive price pressure (not crisis-embedded early on); becomes increasingly crisis-linked later, with pronounced arousal-aligned volatility.

景気

General-purpose benchmark | **Breadth-led (weaker)**

A non-metaphorical descriptor of aggregate economic conditions — comparatively weaker crisis embedding and macro-level change that is primarily breadth-driven.

Conclusion

An interpretable three-level network reveals that metaphorical crisis terms change more deeply — and differently — than a conventional economic benchmark.

1. A three-level semantic change network links micro-level dimensions to a macro-level summary while preserving traceability.

2. The LSCI provides a decomposable yet aggregable change index — comparable across terms and years without creating a new black box.

3. Metaphorical crisis terms carry a heavier share of evaluative framing than the conventional benchmark, but through distinct pathways — breadth-led vs intensity-led.

This framework can be extended to other domains, frames, and languages.

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