RESEARCH PAPER

Adaptive Market Hypothesis: A Narrative Review of Evidence, Methods, and Research Frontiers

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ABSTRACT

Lo's (2004) Adaptive Market Hypothesis (AMH) is a paradigm shift in finance theory because it reconciles the enduring debate between the Efficient Market Hypothesis (EMH) and the emerging evidence in behavioral finance. In contrast to the binary EMH, the AMH considers market efficiency as a dynamic, evolutionary process influenced by competition, investor learning and market conditions. Since its introduction more than 20 years ago, a rich literature has tested the AMH in various markets, securities, and regimes. Yet, there is currently no narrative synthesis of this body of research, which severely limits our understanding of the convergence, market comparison, and behavioral foundations of time-varying efficiency. This paper bridges this gap by providing a structured narrative review of the AMH literature between 2004 and 2025, with evidence from developed, emerging and frontier markets. We review the methodological landscape critically, we conduct a narrative synthesis of empirical evidence across market regimes and crisis periods and we outline five unaddressed research questions. Particular emphasis is placed on the Indian stock market, as a representative institutionally evolving emerging market. The survey ends by sketching a research program based on the price-volume-efficiency link, benchmarking methodology, behavioral micro-foundations, crisis-period dynamics, and institutional factors affecting efficiency in emerging markets. Our synthesis lays down a consistent conceptual framework for academics and practitioners alike to navigate the changing landscape of market efficiency theory.

Keywords: Adaptive Market Hypothesis, Market Efficiency, Efficient Market Hypothesis, Time-Varying Efficiency, Emerging Markets, Behavioral Finance, Price-Volume Relationship, India, Return Predictability

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INTRODUCTION

Capital markets play a pivotal role in resource allocation, risk pricing and information dissemination. For the better part of the last 50 years, the conceptual framework underlying our view of the role of markets in processing information has been dominated by the Efficient Market Hypothesis (EMH), as articulated by Fama (1970). The standard version of the EMH holds that at any point in time the market price of an asset embodies all relevant information, making systematic profit impossible. This simple yet elegant proposition became the bedrock of contemporary financial theory, informing portfolio theory, asset pricing, and the regulatory frameworks of the world.

But the EMH has increasingly run afoul of empirical evidence. Starting in the 1980s, a slew of anomalies - momentum, calendar effects, mean reversion, post-earnings announcement drift - began to find their way into the literature, each calling into question the idea of perpetual efficiency (De Bondt & Thaler, 1985; Jegadeesh & Titman, 1993). A new field of behavioral finance emerged to catalog the systematic biases and rules-of-thumb that steer investors away from rationality (Kahneman & Tversky, 1979; Shiller, 2003). The ensuing philosophical landscape was one of disunity: advocates of the EMH rejected anomalies as spurious or risk premia in disguise, while behavioralists countered with the view that persistent irrationality undermined the efficiency hypothesis (Fama, 1998; Lo, 1999; Shleifer, 2000).

Under these circumstances, Lo (2004) introduced the Adaptive Market Hypothesis (AMH). The AMH brings to market economics principles from evolutionary

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biology and bounded rationality (Simon, 1955), and recasts market participants not as rational optimizers, but as adaptive organisms who compete evolutionarily to survive and thrive. Market efficiency is not an innate market property, but rather a dynamic and emergent property of the ecology of traders, institutions and informational structures. Market anomalies are not due to the irrationality of markets, but because strategies that exploit them attract sufficient funding to arbitrage them away - until a new environment emerges.

The AMH's beauty is its ability to explain findings that are puzzling for both the EMH and purely behavioral models: the time variation in return predictability, cyclical profitability of trading strategies, differences in efficiency at different stages of market development, and crises-induced efficiency breakdowns are to be expected under an evolutionary ecology of markets. Since Lo's (2004) pioneering work, there has been an explosion of empirical studies that seek to verify, extend, and refute the AMH in an ever-growing variety of markets, instruments and methods, documenting time-varying efficiency in mature equity markets (Urquhart & McGroarty, 2014, 2016), emerging markets (Hiremath & Narayan, 2016; dos Santos et al., 2024) frontier markets, currency markets, commodity markets, and cryptocurrency markets.

However, the AMH literature remains piecemeal. Most studies restrict their analyses to one market or a limited range of methodological approaches, which can limit market comparisons. There is disagreement over how to test the AMH's complex dynamics. Moreover, the link between trading volume and the efficiency cycle - a key part of the AMH's evolutionary framework - has received scant empirical attention, nor has the role of behavioural factors (such as herding and overconfidence) in explaining efficiency.

The case of India is particularly informative for assessing the AMH. The Indian equity market - one of the fastest-growing and most institutionally diverse emerging markets - has witnessed breathtaking structural changes over the past three decades: liberalisation of capital markets, entry of foreign institutional investors, multiple reforms of the Security and Exchange Board of India (SEBI), advent of algorithmic trading, and a host of external shocks including the Global Financial Crisis (2008), demonetisation (2016), introduction of the Goods and Services Tax (2017) and the COVID-19 pandemic (2020). Each event is, in AMH terms, a disturbance to the market ecology, which temporarily reduces efficiency but is adapted to by market participants. With available India-centred work (Hiremath & Kumari, 2014; Hiremath & Narayan, 2016; Monga et al. 2024; Mallikarjunappa et al. 2025), there is evidence of time-varying patterns consistent with the AMH, but no synthesis of these findings on a global scale.

Our paper remedies these by undertaking a narrative review of the AMH literature from 2004 to 2025. Our review has four main contributions: (1) a comprehensive theoretical genealogy of the AMH and its predecessors; (2) a systematic overview of the empirical diversity of the AMH literature; (3) a synthesis of the evidence across different markets with a special focus on the Indian market; and (4) a set of five frontier research areas offering an agenda for future research.

The rest of the paper is structured as follows. Section 2 reviews the theory of the AMH and its links to the EMH and behavioral finance. Section 3 discusses the modes of AMH testing. Section 4 presents evidence by market. Section 5 considers the effect of crises and shocks on AMH efficiency. Section 6 is the main research gap analysis, where we point out five avenues. Section 7 concludes with research, practice and policy implications.

Theoretical Foundations of the Adaptive Market Hypothesis

The Efficient Market Hypothesis: Assumptions, Strengths, and Limitations

The EMH, formalised by Fama (1965, 1970), holds that asset prices fully and instantaneously reflect all available information through the action of market forces. The EMH is often divided into three, successively stronger versions: the weak form (prices reflect all historical price and volume data), the semi-strong form (prices reflect all publicly available information), and the strong form (prices reflect all information, including insider information). The normative beauty of the EMH rests on two foundation stones: that rational investors seek to maximise their expected utility, given the available information, and that competition ensures that prices rapidly converge to fundamental value.

The EMH is intimately linked to the random walk hypothesis (Malkiel, 1973; Campbell, Lo & MacKinlay, 1997). If prices incorporate all available information, price changes should be a martingale process - the best predictor of future price change is the current price. This hypothesis spawned a large empirical literature testing for the random walk in various markets using variance ratio tests (Lo & MacKinlay, 1988), runs tests, unit root tests and autocorrelation tests, with generally supportive findings for mature markets during the 1970s and early 1980s.

Yet the evidence of anomalies starting in the 1980s put the empirical EMH into significant peril. The size effect (Banz, 1981), the value premium (Fama & French, 1992), momentum (Jegadeesh & Titman, 1993), the January effect, the day-of-the-week effect and post-earnings announcement drift all reported return anomalies that seemed to violate the strong-form efficiency hypothesis. Theoretically, Grossman and Stiglitz (1980) showed that a perfectly efficient market cannot exist: if all information is fully reflected in prices, no one would be willing to bear the costs of acquiring information, which presents a paradox. This 'Grossman-Stiglitz paradox' suggests there should always be at least some return predictability to justify the costs of information.

Behaviour Finance: Anomalies, Biases, and the Challenge to Rationality

The behavioural finance programme, launched by Kahneman and Tversky (1979) and expanded by their students, provided a coherent explanation of market participants' departure from rational choice. Prospect theory showed that people assess outcomes relative to a reference point and are loss averse, placing a greater weight on losses than on gains. A repertoire of cognitive biases - representativeness, availability, anchoring, and overconfidence - lead to systematic and predictable biases in judgment that, when combined across investors, lead to systematic mispricing.

For asset markets, the behavioral programme generated a number of predictions: that overreaction to recent information drives momentum and reversals (De Bondt & Thaler, 1985); that underreaction to earnings announcements produces post-earnings drift (Bernard & Thomas, 1989); that investor sentiment drives correlated trading patterns and herding (Shiller, 2000); and that limits to arbitrage prevent rational investors from eliminating behavioral mispricings (Shleifer & Vishny, 1997). The evidence generally confirmed these predictions, giving rise to a large anomaly literature which the EMH had difficulty accommodating.

The key theoretical weakness of the behavioral programme is that it uses isolated psychological biases to explain specific anomalies, without a general model of how investor behavior aggregates to set market prices under various conditions. Behavioral models are typically ad hoc and specific to anomalies. They are also open to criticism that biases may offset in the aggregate, or be arbitraged away by rational investors - the motivation for the limits-to-arbitrage literature.

The Adaptive Market Hypothesis: Evolutionary Principles Applied to Finance

Lo's (2004, 2005) AMH was specifically formulated to provide a bridge between the normative efficiency of the EMH and the descriptive realism of behavioural finance, and a theoretical apparatus that could be used to make testable predictions about the evolution of efficiency. The AMH draws analogies between market dynamics and evolutionary biology, in which natural selection, adaptation, competition and ecological balance are key concepts. Participants in the market are not assumed to be perfectly rational, but rather to have characteristics resembling organisms in competition for (profit) resources in an environment that is in perpetual flux.

According to Lo (2004), the main propositions of the AMH are as follows. First, individuals pursue their own self-interest but with occasional errors as a result of cognitive and emotional biases - they are not perfectly rational agents. Second, they learn from and correct these mistakes. Third, market competition leads to innovation in both strategies and products as market participants look to profit. Fourth, there is natural selection of strategies: strategies that are profitable persist and those that are not become extinct. Fifth, market efficiency (reflected in the extent to which prices incorporate all available information) is an evolutionary outcome rather than a static market attribute. Market efficiency at any given moment is an outcome of the composition of the market, the trading strategies in use, and the information environment.

These propositions have a number of implications. Risk-return relations are not constant over time, but depend on the market ecology. Anomalies may exist for long periods until competitive arbitrage wipes them out, and may reappear if the ecology of the market shifts. Investment strategies will display cyclical performance: investment strategies that perform well in terms of generating abnormal returns will attract capital and competition until they are arbitraged away, to re-emerge once the ecology that gave rise to them is restored.

Market crises are extreme shocks to the market ecology that can carry on to have significantly lower efficiency for some time.

The AMH also resolves the Grossman-Stiglitz paradox: in an AMH environment, markets are neither universally efficient nor inefficient, but will exhibit periods of greater and lesser efficiency as a consequence of the ecological processes of competition and adaptation. This leads to periods of return predictability that encourage information gathering and investment management, as well as periods of efficiency that support passive investment strategies. The implication for investors is that the investment strategy of choice is dynamic: it depends on the efficiency level of the market.

The AMH and the Related Theoretical Frameworks

The AMH is conceptually related to, but not identical with, other theoretical approaches. The Fractal Market Hypothesis (Peters, 1994) also rejects the random walk model, arguing that markets are stable if they attract traders with a variety of investment horizons, but unstable if they attract traders with the same investment horizon. Although the AMH and FMH make similar predictions of non-random price movements under certain circumstances, the AMH offers a more detailed picture of how efficiency varies. The Noisy Rational Expectations model (Grossman & Stiglitz, 1980) previews some of the insights of the AMH by showing that a degree of mispricing is needed to incentivize information gathering, but it is not a dynamic evolutionary model.

The AMH is also related to the market microstructure literature. Market microstructure models of price discovery (Kyle, 1985; Glosten & Milgrom, 1985) study how information is reflected into price in the process of trading. The AMH can be seen as providing the "ecological" context for market microstructure: the ability of informed traders to profit from uninformed traders depends on the current efficiency (state of the market), which depends on the dynamics among informed traders. This AMH-microstructure link is not well developed theoretically, and is an important avenue for future research.

Methodological Landscape of AMH Empirical Tests

The Conceptual Challenge of Testing Time-Varying Efficiency

A key methodological issue in testing the AMH is that conventional tests of market efficiency are designed to identify whether a market is efficient or not, rather than to describe the time-varying nature of market efficiency. The traditional variance ratio test (Lo & MacKinlay, 1988), runs test, and tests based on autocorrelations yield a single test statistic for the entire sample period, resulting in an efficient/inefficient decision that cannot reconcile the AMH's prediction of time-variation in efficiency. The crucial innovation needed to test the AMH is therefore a method for detecting time-variation in return predictability.

This observation has been implemented in two main ways: subsample analysis and rolling window analysis. Subsample analysis breaks the total sample period into sub-periods (usually based on known breaks, events, or calendar quarters) and tests for efficiency in each sub-period. The AMH is supported if the market is sometimes efficient and sometimes inefficient, rather than always efficient or always inefficient. Rolling window analysis tests for efficiency in rolling windows of the same length that are incrementally stepped forward in time to produce a time series of efficiency estimates. This method offers a more detailed picture of efficiency dynamics, but is potentially sensitive to window size.

Linear Predictability Tests

The two most popular linear tests for AMH are the variance ratio test and autocorrelation tests such as the Ljung-Box Q-statistic and Box-Pierce portmanteau tests. The variance ratio test (Lo & MacKinlay, 1988; Kim, 2009), originally proposed to test the random walk hypothesis, tests for linearity in the relationship between the variance of an asset's returns and the length of the holding period; nonlinearity implies serial correlation and hence return predictability. Kim's (2009) wild bootstrap automatic variance ratio test has been the most commonly used version in AMH studies since it allows for conditional heteroskedasticity and does not require specification of the lag length.

Autocorrelation tests such as the Ljung-Box Q-statistic jointly test whether the autocorrelations up to a certain lag are zero. They have been extensively used in rolling window AMH studies. The main drawback of these tests is that they can only detect linear serial correlation, and may be incapable of detecting the nonlinear serial correlation patterns found in behavioral finance studies. Recent studies of the Finnish market (Akhter & Yong,

2024) have shown that tests that detect linear autocorrelation (variance ratio and Ljung-Box) yield similar results when applied to a rolling window framework because they are then equivalent to tests of first-order autocorrelation when returns are homoscedastic.

Nonlinear Predictability Tests

Aware of the shortcomings of linear tests, a major branch of the AMH literature uses nonlinear tests which can capture more complex relationships in returns. The BDS test (Brock, Dechert & Scheinkman, 1987) is a general test for nonlinear dependence that uses the correlation integral, and has power against a variety of nonlinear alternatives. The Dominguez-Lobato (2003) consistent test and the generalized spectral test (Hong, 1999) are nonparametric tests of the martingale difference hypothesis - that past returns have no predictive information for future returns - that are robust to a wide range of conditional heteroskedasticity and nonlinear dependence structures. The tests have been used in the cryptocurrency markets (Khuntia & Pattanayak, 2018) and crude oil markets to capture the time-varying nonlinear efficiency dynamics consistent with the AMH.

The salient insight from studies that use both linear and nonlinear tests is that the two sets of tests do not always show the same results: markets that are efficient with linear tests may display nonlinear dependence, and vice versa. This methodological split has implications for the interpretation of AMH results, and suggests that multiple tests should be used in AMH studies. Urquhart and McGroarty (2014) conduct a study of the DJIA and find that the combination of subsample and rolling window tests conducted using both linear and nonlinear tests yield the most compelling evidence for the AMH.

Long Memory and Fractal Methods

A unique branch of AMH empirical literature adopts measures of long-range dependence, such as the Hurst exponent, to describe the efficiency cycle. The Hurst exponent, originally proposed by Hurst (1951) and adapted to financial markets by Mandelbrot (1971), quantifies the extent of long-memory in a time series. A Hurst exponent of 0.5 is consistent with a random walk (weak-form efficiency); a value greater than 0.5 is consistent with positive long-memory (persistent returns); and a value less than 0.5 is consistent with anti-persistence (mean-reverting returns). According to the AMH, the Hurst exponent would vary over time around the 0.5 random walk value in response to changing market conditions.

The Generalized Hurst Exponent (GHE) framework, both in fixed and rolling window frameworks, has been widely applied in the Indian market (Hiremath & Narayan, 2016) and in cross-market analyses. Multifractal Detrended Fluctuation Analysis (MF-DFA) is derived from the Hurst exponent to address issues of multifractality of efficiency at different scales, capturing the behaviour of small and large fluctuations differently. Recent research on wavelet-based calculations of the Hurst exponent has shown the effectiveness of this approach in the presence of microstructure noise and seasonality (Webb et al., 2025), bringing a new dimension to high-frequency AMH tests.

Wavelet Analysis

The use of wavelets has emerged as an important supplement to time-domain analysis in AMH studies, as it allows researchers to analyse return time series simultaneously in the time and frequency domains. This feature is very useful for AMH testing because it allows researchers to test whether efficiency changes are present not only across time but also across investment horizons - a key prediction of the AMH, given its emphasis on the role of different types of traders with different horizons. Wavelet coherence has been applied to study the co-movement of efficiency in different markets, offering a better understanding of contagion effects during crises in market efficiency.

Machine Learning Approaches

The cutting-edge of AMH research is the use of machine learning, and in particular deep learning, to model the nonlinearity of the efficiency cycle. Villavicencio et al. (2023) and subsequent research (ScienceDirect, 2025) have shown that Long Short-Term Memory (LSTM) neural networks can be applied to the testing of the AMH by investigating the speed of recovery of the model's prediction error after a change in market environment - a direct test of the speed of adaptation predicted by the AMH. The authors' main contribution is that even non-heuristic machine learning models show the same slow adaptation following environmental change as predicted by the AMH, confirming the latter using a completely different approach.

The use of machine learning for AMH testing is still in its infancy, with many questions to be addressed regarding model specification, testing, and interpretability. Yet this development is promising in integrating the complexity of the dynamics of efficiency, and perhaps resolving the differing conclusions from the linear and nonlinear parametric tests.

Table 1: Summary of Methodological Approaches in AMH Empirical Literature

Method	Key References	Strengths	Limitations
Variance Ratio Test	Lo & MacKinlay (1988); Kim (2009)	Robust to heteroskedasticity; widely benchmarked	Detects only linear dependence
Runs / Ljung-Box Test	Box & Pierce (1970); Ljung & Box (1978)	Simple, intuitive, non-parametric	Low power against nonlinear alternatives
BDS Test	Brock et al. (1987)	Detects nonlinear dependence	Sensitive to parameter choice
Generalized Spectral Test	Hong (1999); Dominguez & Lobato (2003)	Robust MDH test; no lag truncation	Computationally intensive
Hurst Exponent / MF-DFA	Hurst (1951); Mandelbrot (1971); Hiremath & Narayan (2016)	Captures long memory; multi-scale	Sensitive to window length; estimation bias
Wavelet Analysis	Gençay et al. (2001); Webb et al. (2025)	Time-frequency decomposition; robust to noise	Interpretability; boundary effects
Machine Learning (LSTM)	Villavicencio et al. (2023); ScienceDirect (2025)	Captures nonlinear dynamics holistically	Black-box; overfitting risk

Empirical Evidence by Market Type

Developed Markets

The empirical testing of the AMH has started in developed markets, where the data are sufficient and of high quality to perform long sample tests. Kim, Shamsuddin and Lim (2011) offer one of the first such comprehensive tests, considering a 100-year sample of the DJIA using variance ratio and portmanteau tests within a rolling window. They find strong evidence of significant time-variation in return predictability, with the US market moving through several periods of efficiency and inefficiency, especially during major economic events. Urquhart and McGroarty (2014, 2016), studying the DJIA between 1900 and 2013 and, more recently, five key global equity indices, provide evidence that both the anomalies and return predictability are time-varying, consistent with the AMH, and not the EMH.

A notable aspect of the evidence in developed markets is that efficiency poor patches correspond to important events. The Great Depression, World War II, the 1973 Oil Crisis, the late 1990s technology bubble and the 2008 Global Financial Crisis have all led to documented efficiency deterioration in the US and Europe. This is exactly what the AMH predicts: external shocks transform the market ecology, by shifting the composition and actions of market participants, to temporarily generate exploitable mispricings until the price adjustment process reinstates efficiency.

For smaller developed markets, Akhter and Yong (2024) study the Finnish stock market (OMXH25 index) and find strong evidence in support of the AMH, and that market size is not a determinant of efficiency (contrary to the conventional wisdom that market size and liquidity are important for efficiency). Evidence from the French market (rolling variance ratio tests for 1988-2018) also shows time-varying efficiency and inefficiency in line with the AMH, with inefficiency especially during major macroeconomic events.

Emerging Markets

There has been a surge in AMH studies of emerging markets in the last decade, with India, China, Brazil, Turkey and South Asian markets being the most-studied markets. The overall takeaway from these studies is that emerging markets show a greater level of efficiency variation than mature markets, and that the efficiency of these markets is heavily influenced by institutional factors, market liberalization, and macroeconomic variables.

There are many studies on China using both calendar anomalies and return predictability. Xiong et al. (2019) test four calendar effects in Chinese stock market indices using subsample and rolling window tests, and find that all four effects are time-varying, as predicted by the AMH. The Chinese market seems to have evolved towards efficiency in the 2000s as securities markets opened to foreign competition, in line with Lo's (2012) argument that markets adapt to become more efficient as competition intensifies.

The case of Turkey offers insights into the efficiency of a politically turbulent emerging market. Mandacı et al. (2019) examine variance ratio and BDS tests for three Borsa Istanbul indices between 2002 and 2017, and report that while linear tests indicate overall efficiency, nonlinear tests show adaptive markets with high efficiency variability. The discrepancy between linear and nonlinear tests, as observed across a number of emerging markets, implies that the efficiency dynamics in emerging markets are nonlinear and may be driven by informed trader actions and institutional herding, which are not captured by linear tests.

International evidence from 50 markets over 1990-2022 (dos Santos et al., 2024) shows that the economic-institutional milieu has a significant impact on the level and dynamics of market efficiency. Markets with better institutional environments (well-defined property rights, independent regulatory agencies, disclosure practices) display higher levels of efficiency and quicker restoration of efficiency after a period of efficiency loss. This insight has key implications for emerging market governance and regulation.

The Indian Market: A Focused Review

India's equity market holds a special place in the AMH literature owing to its institutional complexity, rapid institutional evolution and data richness. India's two major exchanges - the Bombay Stock Exchange (BSE), founded in 1875 and one of the oldest in Asia, and the National Stock Exchange (NSE), founded in 1992 - offer complementary data sets for different time periods and types of investors. The reforms of Indian capital markets in the early 1990s, the gradual liberalization of the market to foreign institutional investors (FIIs), and the introduction of derivatives trading in 2000 are three significant changes in the market ecology that according to the AMH framework should lead to efficiency transitions.

One of the first formal tests of the AMH for India, based on data for the Nifty and Sensex indices, is Hiremath and Kumari (2014), who report evidence of time-varying return predictability as predicted by the AMH. Importantly, their findings imply that the Indian market has been evolving towards efficiency over time; the introduction of derivatives trading and a progressive liberalization of foreign investment have been associated with better efficiency. This dynamic perspective is the AMH's primary implication for an institutional reforming market, rather than a one-time efficiency judgement.

Hiremath and Narayan (2016) take this work further using the Generalized Hurst Exponent under rolling and fixed windows, and report that long-range dependence is not a constant and that the efficiency gap (the difference between the estimated Hurst exponent and the theoretical value of 0.5 in a random walk) is strongly related to financial crises and key local policy events. Interestingly, net FII flows are found to impact the efficiency gap positively, implying that while foreign institutional participation in general is linked to better price discovery in aggregate, it also brings in volatility and herding patterns that are conducive to lowering market efficiency temporarily.

More recently, Monga, Aggarwal and Singh (2024) investigate the EMH and AMH for the Indian equity market, concluding that market efficiency is time-varying, with both efficient and inefficient segments, and that the AMH better describes the Indian market than EMH. Mallikarjunappa et al. (2025) test for cyclical market efficiency in India, Brazil and South Africa, and conclude that market efficiency is not an end state, but rather a continuous process that is sensitive to the environment. Prestianawati (2025) tests the AMH using day-of-the-week (DOW) effects under rolling window framework, finding time-varying DOW effects with phase characteristics in line with major economic events in India such as demonetisation, GST and COVID-19.

Across the evidence, we see that the AMH view of the Indian market as a dynamic and adaptive system is supported. The market seems to have become more efficient in the 1990s and early 2000s with rapid institutional reforms, but has had periodic efficiency shocks linked to policy shocks and international crises. The mode of transmission of these shocks - whether via information asymmetries, herding or liquidity effects - remains a live empirical issue that is unresolved by the available literature.

Frontier Markets and Alternative Asset Classes

The AMH has also been applied to other asset classes and frontier markets. The crude oil markets have been investigated using automatic portmanteau and generalized spectral tests under rolling windows (Ghazani & Ebrahimi, 2019), and the findings reveal that the Brent and WTI markets are the most efficient and that AMH compliance decreases as the size of the rolling window increases - implying that short-horizon efficiency effects are more pervasive than long-horizon effects.

Perhaps the most actively researched non-equity market test of the AMH is cryptocurrency markets. Bitcoin markets, studied using Dominguez-Lobato and generalized spectral tests (Khuntia & Pattanayak, 2018), are found to show time-varying linear and nonlinear dependence, as predicted by the AMH. Across the cryptocurrency studies, the common theme is that these markets are highly dynamic in terms of efficiency, reflecting their relative youth, regulatory uncertainty and the ever-evolving mix of market participants, the very conditions under which the AMH predicts the greatest evolutionary activity.

The AMH Under Financial Crises and Structural Shocks

The AMH Framework for Financial Crises

Crises are the ultimate test of the AMH's evolutionary approach, as they represent a major unexpected shock to the ecology of the market that can simultaneously produce changes in its participants, their interactions, its liquidity, and its information content. Under the EMH, an efficient crisis response should quickly reflect crisis information in prices, with no systematic return predictability during or after the crisis. In contrast, the AMH predicts that crises should give rise to periods of increased return predictability as market participants adapt to the new ecological conditions - with recovery patterns depending on the pace of adaptation and the magnitude of the ecological shock.

The AMH crisis model makes a number of predictions. First, large market crises should be associated with higher return predictability and lower market efficiency. Second, the efficiency loss should depend on the strength and unexpectedness of the shock - stronger, unexpected shocks should cause larger and longer-lived efficiency gaps. Third, the return to efficiency should feature a distinctive trajectory: initially gradual as market participants try to implement strategies that are no longer effective in the market environment and then a rapid improvement as new strategies are identified and spread via competitive imitation. Fourth, the effect of a shock on market efficiency should depend on the institutional features of the market, the types of participants involved, and the extent of its market ecology.

Global Financial Crisis (2008)

The Global Financial Crisis (GFC) of 2007-2009 offers the best data for testing AMH predictions of crisis impacts, due to the simultaneous nature of the shock across markets and the availability of high-frequency data before, during and after the crisis. A common theme across the AMH studies of this period is that efficiency in both advanced and emerging markets suffered a major disruption after the start of the crisis, with increased return predictability observed across equity, currency and commodity markets.

In the context of Indian markets, the GFC created a significant efficiency gap for Nifty and Sensex indices, with the Hurst exponent moving above its pre-crisis level and staying above for a long period, only to converge towards the random walk value over a period of time (Hiremath & Narayan, 2016). This efficiency gap is likely to be linked to the exit of Foreign Institutional

Investors (FIIs) who acted as informed liquidity providers and led to temporary price discovery inefficiencies. Cross-country analysis for the E-7 and G-7 markets (using wavelet-based Hurst exponent and network analysis) reveals a marked upward trend in long memory behavior in the post-GFC period, with evidence of a greater degree of dependency in efficiency dynamics across markets, supporting the idea that inefficiency during the GFC had a contagion element.

The COVID-19 Pandemic (2020-2022)

The COVID-19 pandemic provides an extreme test of the AMH's crisis framework, with the shock occurring simultaneously across almost all markets, having non-financial origins, and incorporating elements of demand, supply and uncertainty which contradicted the formation of rational expectations. The initial reaction in the equity markets was extreme: in India, the BSE Sensex recorded a 13.2 percent decline on March 23, 2020, the biggest one-day fall since 1992, and the NSE Nifty fell roughly 29 percent from its pre-pandemic high, with some economists describing the event as a 'black swan' (Mishra et al., 2020).

There were several AMH-consistent aspects of the Indian market's crisis response. Variance ratio tests on various sectoral BSE indices indicate marked departures from the random walk model during the pandemic period, with most sectors showing non-random return dynamics, inconsistent with the EMH but consistent with the AMH's hypothesis that markets are inefficient during crises (BIMTECH, 2022). Post-pandemic returns exhibit positive autocorrelation at longer lags for the Sensex index, implying a momentum-like effect as the market's recovery path was set. Prestianawati (2025) shows that the 2020-2023 rolling window period is inefficient, and offers direct support for the AMH in terms of the day-of-the-week effect.

Comparative international evidence from 16 stock market indices (Urquhart & McGroarty, 2022) shows that calendar anomalies re-emerged or were exacerbated after the onset of COVID-19 in several markets, as predicted by the AMH that the ecological disruption of the crisis period re-opens efficiency gaps in markets that have been eliminated by competitive arbitrage. Efficiency recovery speeded up considerably across markets, with institutional factors (regulatory quality, market size, government economic policy effectiveness) seemingly instrumental to recovery patterns.

India-Specific Structural Shocks: Demonetization and GST

The Indian market offers a rare opportunity to test the AMH predictions on domestic policy-based structural shocks, in addition to global crises. The November 2016 demonetisation - the overnight liquidation of 86 percent of the currency in circulation - is a unique, extreme policy shock in recent financial history. Event study results reveal a short-lived negative reaction of the equity market and swift recovery in about a month (PMC, 2022), evidence of rapid investor adjustment as predicted by the AMH. But aggregate market recovery masks sectoral differences: cash-intensive sectors were adversely affected and suffered more prolonged disruptions, while financial and digital payments sectors profited.

A second institutional disruption event was the roll-out of the Goods and Services Tax (GST) in July 2017, which has changed the entire indirect tax structure of the Indian economy and has forced significant operational adaptation by listed firms across sectors. The AMH framework implies that such restructuring shocks should temporarily raise information asymmetry between firms with varying GST exposure, creating sectoral efficiency gaps while overall market efficiency is preserved. This is a particular empirical prediction that has not been tested so far.

The evidence from the history of efficiency in India's past structural shocks strongly supports the AMH's view of efficiency as an evolutionary and environmentally-dependent construct. The Indian market does not steadily increase in efficiency over time, in a monotonic fashion, but rather, it fluctuates between periods of relative efficiency and inefficiency in response to the constant shocks arising from institutional reform, policy shocks and global financial cycles. This is the unique prediction of AMH and its most unambiguous empirical confirmation.

Research Gaps and Future Directions

Nearly two decades of empirical research on AMH has produced a literature that has major gaps that undermine its theoretical clarity and predictive power. This section highlights and discusses five frontier research areas with weak, conflicting, or precarious empirical evidence.

The Price-Volume-Efficiency Nexus

The most important frontier in the AMH literature is the treatment of trading volume in the efficiency cycle. The evolutionary logic of the AMH is a narrative about market participation - the arrival and departure of traders, the evolution of trading strategies and the competitive outcomes among traders. Volume is the most obvious observable measure of market participation and the intensity of information trading, yet most AMH studies solely focus on return predictability, and volume at best as a control variable.

There are strong theoretical arguments for incorporating volume into AMH testing. In the Mixture of Distributions Hypothesis (MDH) (Clark, 1973) and the Sequential Information Arrival (SIA) (Copeland, 1976) models, volume and price changes are co-determined by the information flow. If market efficiency is a time-varying function of the competitive ecology of informed and uninformed traders, then volume should co-evolve with efficiency in predictable ways: periods of low efficiency should be associated with higher information asymmetry resulting in volume-price dynamics that differ from those in efficient periods. Some recent research has taken steps towards addressing this question, such as Mallikarjunappa et al. (2025) who find that the price-volume relationship is time-varying and dependent on the state of market efficiency. But no research has yet explicitly modelled the price-volume relationship as an integral part of the AMH dynamic efficiency cycle across a broad sample of markets. The next frontier of research should be to build on this work by proposing structural models of volume-investment as a function of efficiency and test them on high-frequency data from different market structures.

Methodology Diversity and Benchmarking

The AMH empirical literature is marked by significant methodological diversity that limits the ability to build knowledge. Researchers use a broad range of methods (variance ratio tests, runs tests, BDS tests, Hurst exponent, multifractal detrended fluctuation analysis (MF-DFA), wavelet decomposition, machine learning, among others) with little research on which methods are most sensitive to the time-varying efficiency dynamics proposed under the AMH. This poses a major inferential problem: observed differences in results across studies may be due to cross-market differences, but may also result from the different power properties of the testing methods.

As recent theoretical work has shown, the existence of periods of statistically significant return predictability can be accounted for by methodological concerns such as multiple comparison effects that are typically ignored in the AMH literature (Hřebačka, 2024). Rolling-window tests will yield spurious periods of apparent inefficiency at predictable rates even if the market is efficient. These findings suggest much of the empirical evidence in support of the AMH may not reflect reality but rather be statistical spuriousness. The research community should look to benchmarking studies and develop testing standards like PRISMA for systematic reviews.

Behavioral Micro-Foundations of Time-Varying Efficiency

The AMH is a theory of market dynamics based on behavioral mechanisms, but empirical studies testing the AMH have been astonishingly blind to the behavior processes that are supposed to be at the core of efficiency variation. The typical approach - detection of return predictability using time-series techniques - demonstrates the correspondence between efficiency states and clock time, but it does not provide direct evidence about how efficiency varies as a result of behavioral processes. Research on herding, overconfidence, and adaptability in frontier markets (Jannatunnesa et al., 2026) shows that behavioral biases are indeed time- and context-dependent, as proposed by the AMH, but these behavioral studies are seldom linked with the related return predictability literature.

Future studies should build integrated empirical models where direct measures of investor sentiment, attention, and bias (obtained from surveys, social media, Google Trends, or microstructure data) are related to the efficiency cycle identified by return predictability methods. This will offer the AMH the micro-foundations it lacks and strengthen its theoretical superiority over the EMH and pure behavioral approaches.

Crises: Re-equilibration and Contagion

Though the AMH's crisis-driven decline in efficiency is well documented, recovery trajectories have not received the same level of attention as the initial decline in efficiency. The dynamics of re-equilibration after a crisis are theoretically important for the AMH framework's evolutionary theory: faster recovery implies a more resilient market ecosystem with diverse and flexible market participants. The determinants of recovery -

regulatory quality, market depth, foreign ownership, institutional diversity - have been studied in only a few cross-market studies.

And the channels whereby global crises impacted the price-volume-efficiency dynamics of various markets, especially emerging markets such as India, are poorly understood. The COVID-19 pandemic, with its simultaneous global impact on markets with very different institutional features, offers a particularly rich opportunity for comparative cross-market investigations of crisis transmission and recovery. We need to develop comparative models of efficiency cycles around crisis periods, with explicit consideration of the institutional and microstructural channels of recovery.

AMH in Emerging Markets: Institutional Factors

The AMH literature is dominated by evidence from mature markets, with scant and scattered evidence from emerging and frontier markets. This distribution is theoretically problematic because the AMH's hypotheses about evolutionary efficiency dynamics can be directly tested in markets that are institutionally diverse and where the population of market participants is in flux. In the Indian market, empirical evidence on the relative efficiency of the large-cap versus small-cap segments, effects of SEBI regulatory reforms, the role of FII inflows in modulating market efficiency and the specific role of algorithmic trading in the efficiency cycle is very limited.

The missing piece in this puzzle is an institutionally-focused study of AMH dynamics in the Indian market, as part of a comparative study of emerging markets. This work addresses policy questions of market regulation, foreign capital regulation and market microstructure in emerging markets. It would also speak to the question of whether the AMH dynamics in India reflect the general patterns observed in emerging markets or are unique to those in India.

Table 2: Summary of Research Gaps and Future Directions

Research Gap	Core Issue	Recommended Future Research
Price-Volume-Efficiency Nexus	Volume neglected despite being central to AMH's evolutionary logic	Structural models linking volume dynamics to efficiency states using high-frequency data
Methodological Fragmentation	No standardized testing protocol; spurious findings likely	Comparative benchmarking studies; meta-analytic corrections for heterogeneity
Behavioral Micro-Foundations	Behavioral mechanisms driving efficiency variation are unobserved	Integrate sentiment, herding, and attention measures into efficiency-cycle models
Crisis Recovery Dynamics	Recovery trajectories and transmission channels understudied	Cross-market comparative frameworks for efficiency crisis and recovery analysis
Emerging Market Institutions	India-specific institutional drivers of efficiency unexplored	Institutionally-grounded AMH study of Indian market in comparative EM context

Conclusion

This paper has delivered a narrative review of the Adaptive Market Hypothesis (AMH) literature since its inception in 2004 to 2025, reviewing the evolution of theory, methods, and empirical evidence across developed, emerging, and frontier markets. The review's key conclusion is that the AMH has produced a large and growing body of empirical evidence: time-varying return predictability, as predicted by the AMH's evolutionary approach, has been shown to exist across nearly every type of market and asset class explored, with efficiency fluctuations shown to be systematically tied to competitive forces, institutional reform and crises.

This review highlights the Indian stock market as a fertile ground for AMH research. The market's institutional diversity, rapid institutional evolution and frequent domestic policy shocks are the conditions that give rise to the efficiency cycle dynamics that the AMH predicts. The empirical evidence reveals pronounced efficiency variations of both Nifty and Sensex indices, with efficiency gaps linked to liberalisation episodes, FII inflows, the global financial crisis (GFC), demonetisation, GST, and COVID-19. The Indian market's movement - not steadily towards efficiency, but adaptively to-and-fro in response to an ever-evolving ecological niche - is the AMH's empirical fingerprint.

For academics, the present review identifies five emerging research areas in the AMH domain where much more research needs to be done, namely the price-volume-efficiency nexus, methodological homogeneity, behavioural micro-foundations, post-crisis recovery, and institutional factors underlying efficiency in emerging markets. These avenues involve cross-disciplinary research, bringing together market microstructure, behavioral finance, institutional economics and machine learning in ways not yet done in AMH research.

For market practitioners and portfolio managers, the AMH's key insight that the optimal investment strategy is dynamic, and depends on the efficiency regime, suggests that dynamic, regime-switching portfolio management should outperform both passive index tracking (assuming permanent efficiency) and static active management (assuming permanent inefficiency). The discovery of timely and informative indicators of the efficiency cycle, through the price-volume dynamics, behavioral and institutional signals identified in this review, is a practically important research program with implications for investment strategy.

For policymakers and regulators, the AMH's focus on the role of market ecology - participant mix, competition, institutional quality - in determining market efficiency implies that market design has significant efficiency implications. Incentives for a diverse participant base, the avoidance of herding, and the further development of the institutional infrastructure for efficient price discovery should, according to AMH, speed up the evolutionary adaptation towards higher and (more) robust efficiency. In India, SEBI's ongoing reform agenda provides an ongoing natural experiment in the management of market ecology whose efficiency consequences can be subject to rigorous empirical investigation.

Finally, the Adaptive Market Hypothesis is not merely a different and interesting intellectual alternative to the Efficient Market Hypothesis, but a different and more productive way of thinking about market outcomes in the world of bounded rationality, competitive adaptation and institutional evolution. The empirical program stimulated by Lo's (2004) seminal work is rich and fertile, and it is only two decades old. The research program we outline here suggests that the best days for AMH research are still to come

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