Yew Joe Ho[1], Chee Heong Quah[2]

EXPLAINING SLOW SELL-OFF AT STOCK MARKET AFTER YIELD CURVE INVERSION WITH CLOCK GAME

This paper reviews various theories and hypotheses of stock market which are in contradiction with the conventional Efficient Market Hypothesis (EMH). It also explores the reasons that lead to a prolonged sell-off at stock market after the inversion of yield curve which is a strong signal to an imminent stock market crash. It is proposed that dynamic interaction among various stakeholders at a market and their extensive engagement in the clock game are some of the plausible reasons to the prolonged sell off. The highly complex and self-feeding nature of the financial market negate the initiatives of quantitative analysis and forecasting of stock market crash.

Keywords: *stock market crash; business cycle; yield curve inversion; clock game.*

Ю Жоі Хо, Чі Хеон Цюа

ПОЯСНЕННЯ ПОВІЛЬНОГО РОЗПРОДАЖУ НА ФОНДОВОМУ РИНКУ ПІСЛЯ ІНВЕРСІЇ КРИВОЇ ПРИБУТКОВОСТІ ЗА ДОПОМОГОЮ ЧАСОВОЇ ГРИ

У статті розглянуто різні теорії і гіпотези фондового ринку, які знаходяться в протиріччі із загальноприйнятою гіпотезою ефективного ринку (ЕМН). Досліджено причини, які приводять до сповільненого розпродажу на фондовому ринку після інверсії кривої дохідності, яка є потужним сигналом неминучого краху фондового ринку. Передбачається, що динамічна взаємодія між різними власниками цінних паперів на ринку і їхня широка участь у часовій грі — деякі з правдоподібних причин тривалих розпродажів. Дуже складний характер фінансових ринків і закрита природа фондового ринку зводять нанівець спроби кількісного аналізу і прогнозування обвалу фондового ринку.

Ключові слова: обвал фондового ринку; бізнес-цикл; інверсія кривої прибутковості; часова гра.

Ю Жои Хо, Чи Хеон Цюа

ОБЪЯСНЕНИЕ МЕДЛЕННОЙ РАСПРОДАЖИ НА ФОНДОВОМ РЫНКЕ ПОСЛЕ ИНВЕРСИИ КРИВОЙ ДОХОДНОСТИ ПОСРЕДСТВОМ ВРЕМЕННОЙ ИГРЫ

В статье рассматрены различные теории и гипотезы фондового рынка, которые находятся в противоречии с общепринятой гипотезой эффективного рынка (ЕМН). Исследованы причины, которые приводят к замедленной распродаже на фондовом рынке после инверсии кривой доходности, которая является мощным сигналом неизбежного краха фондового рынка. Предполагается, что динамическое взаимодействие между различными владельцами ценных бумаг на рынке и их широкое участие во временной игре — некоторые из правдоподобных причин длительных распродаж. Очень сложный характер финансовых рынков и закрытая природа фондового рынка сводят на нет попытки количественного анализа и прогнозирования обвала фондового рынка.

Ключевые слова: *обвал фондового рынка; бизнес-цикл; инверсия кривой доходности; временная игра.*

[1] PhD Candidate, Faculty of Economics and Administration, University of Malaya, Kuala Lumpur, Malaysia.
[2]PhD, Senior Lecturer, Faculty of Business and Accountancy, University of Malaya, Kuala Lumpur, Malaysia.

1. Introduction. Financial markets are inextricably linked to the real economy. All rational investment decisions contain explicit or implicit judgment about current and future economic conditions. Consequently, the starting point for any market timing decision is an assessment of the position of the economy within the business cycle and the predicted trajectory of the economy going forward. It is the business cycle which captures and articulates the evolution of the economy through time.

A business or growth cycle can usefully be divided into 4 major phases: economic expansion from below trend growth to a "normal" rate of growth; economic growth above a sustainable noninflationary level; a cyclical peak in growth, followed by a decline in the rate of growth toward the trend rate; and growth falling below trend toward a cyclical trough. From an investor's perspective, each phase of the cycle has relevant implications for returns to different asset classes (Taylor, 1998). Amongst assets, equities perform best when the economy is operating below potential and experience their strongest performance months before the economy emerges from recession.

Whilst economic fundamentals are relatively stable, financial markets are comparatively highly chaotic. Essentially, the precociousness of the markets is quintessentially linked to a multitude of investment strategies adopted at a market including but not limited to market-timing, trend-following, both associated with technical analysis (i.e. charting, time series, regression etc.) and the buy-and-hold strategy based on fundamental analysis.

Along these lines, this paper presents the arguments why, in light of the complexity of financial markets, quantitative modeling approach might not be appropriate in predicting the onset of an imminent market collapse or recession. The rest of the paper is structured as follows. Section 2 briefs the reasons behind stock market crash. Section 3 explores the relationships between stock market condition, yield curve, and business cycle. Section 4 addresses why there is such a prolonged sell-off upon yield curve inversion. Section 5 discusses the limitations of quantitative analysis in explaining and predicting stock market crashes and recessions. Finally, Section 6 concludes.

2. Explaining Stock Market Crash. A healthy economy rarely triggers a financial crisis or a stock market crash. This postulation nevertheless runs into contradiction with efficient market hypothesis (EMH) of which most financial modeling techniques were based upon.

According to Cooper (2008), the EMH assumes that asset prices are always in equilibrium and mirror the asset value correctly at any time, adjusted based on all available information at the market. The hypothesis is thus ignorant to the fact that in most times market rally occurs even stock prices have reached an overly inflated and unsustainable level due to speculative herding (Shiller, 2005). Shiller (2003) and Cross et al. (2005) even argue that EMH is fundamentally flawed because it fails to replicate the critical attributes of the market behavior in reality and the shortcomings "manifests itself most clearly in the real-world phenomena of non-Gaussian market statistics such as fat-tails, excess kurtosis and volatility clustering (and the corresponding market bubbles and crashes)".

In the evolution of the market morphing from a stable state to an unstable one, it is common to see patterns of thresholds being breached in a hierarchical manner. As said by Sornette (2003), there are 5 common stages to the building up of bubble

that leads to an eventual stock market crash: (1) displacement, (2) take-off, (3) exuberance, (4) critical stage and lastly (5) crash. In the transition from instability to abrupt crash, market volatility due to continuous feedback loop of actions and reactions by investors and the authority to keep the market afloat would still create an impression that the market conforms to the EMH (Cooper, 2008).

Nevertheless, as Arthur (1995) put it, instead of conformity to EMH, a crash is merely the tipping point of the underlying complex phenomena that occur throughout an extended course of time. Along this line, Sornette (2003) opined that the inherent herding nature of traders at the market, especially during the upward trend of stock prices, would reinforce the market optimism and create a loop that further inflates market bubble. He further argued that an explicit cause that triggers a market collapse is superficial. When the market passes the instability threshold, any minor or exogenous disruption would catalyze a meltdown. The financial market is a complex system that encompasses a network of individual systems that are dynamics and exhibit resembling behavior. The interactions among large integrated units in the overall system usually exhibit self-organizing pattern.

Meantime, White (2008) noted that in virtually all financial crises, overpricing of assets is largely due to credit expansions. Excessive flows of credit into the market enhance market's optimism and hence encourage risk-taking among investors. In progression, the asset prices would deviate from the intrinsic asset values and the fundamentals of the economy. This distortion would then manifest in the change of consumption - investment pattern. At the critical point when the market has transcended the instability threshold where the realization of unrealistic level of asset prices catches up with the market expectation, the whole endogenous process would reverse. When the bubble bursts, the economy would experience the collateral damage and adversity would be exacerbated by the strain in the financial market following the prior credit expansion. The feedback loop is once again set in motion but in the reverse direction. White stressed that most of the forecasting models only describe a section of the whole occurrence and due to the complexity of the market, a qualitative assessment would seem to be a more appropriate option.

3. Stock Market, Yield Curve and Business Cycle. Over the years, economists provided evidence that stock and bond market data contain information relevant for predicting future economic conditions. The dynamic relationship between stock market fluctuation and the state of business cycle was explored extensively and according to Chauvet (1999), stock market index is useful in predicting the state of the business cycle especially the onset of recession. In the same vein, Casarin and Trecroci (2007) concluded that macroeconomic and financial indicators share common volatility patterns. Apart from business cycle, shorter-term cycles such as seasonality and calendar effects are also significantly linked to stock market.

How can the stock market condition predict business cycle? McCown (2007) noted that during the business cycles of the last few decades, stock prices have declined just before and during the recession phase. But the decline is very slow, taking as long as 18 months before the lowest point is reached. The decrease in stock prices and the consequent negative returns have well-documented by, for instance, Boudoukh, Richardson and Smith (1993) and McCown (1999).

On the other front, several authors found the bond market or the yield curve as a more valid predictor of recession. The yield curve most often used is the one representing the rates of return of treasury bonds against their maturity dates. Normally, the yield curve which plots the yields of Treasury bonds against their maturities is typically upward sloping and somewhat convex (Haubrich & Dombrosky, 1996). When the curve gets flat or slopes downward, it is an indicator of economic recession in the future (Shaaf, 2000).

Under the expectations hypothesis (neglecting term premiums), the term spread (short-term rates less long-term yields) measures the difference between current short-term interest rates and the average of expected future short-term interest rates over a relatively long horizon (Wright, 2006). The term spread is thus a measure of the stance of monetary policy relative to long-run expectations. The larger is the term spread, the more restrictive is the current monetary policy, and the greater is the likeliness of a recession over the subsequent quarters.

Forecasting with the yield curve has a number of advantages. First, one can mean the difference between a large profit and a large loss. Second, bond yields are available on a minute-to-minute basis. Third, indication of an inversion does not require sophisticated analysis. Fourth, one may not know that the business cycle peak has passed until months or years after the fact, but one can observe the inverted yield curve that occurs at, or just prior to, the peak.

Table 1 shows the dates of yield curve inversions and dates of business cycle troughs and peaks. Based on the evidence, it is persuasive to conjecture a positive relationship inversion of yield curve and beginning of a recession. An inverted yield curve indicates a recession in about a year, and in fact yield curve inversion has preceded each of the 7 more recent recessions in the US. In particular, the yield curve inverted in August 2006, a bit more than a year before the current recession started in December 2007.

Table 1. **Yield curve inversions and recessions**

NBER Business Cycle Peak	S&P 500 Index at Business Cycle Peak*	Date of Minimum of S&P 500 Index	Number of Months from Peak to S&P 500 Minimum	Local Minimum of S&P 500 Index after Business Cycle Peak	Percentage Drop
December, 1969	92.06	June, 1970	6	72.72	-21.01
November, 1973	95.96	September, 1974	10	63.54	-33.79
January, 1980	114.16	March, 1980	2	102.09	-10.57
July, 1981	130.92	July, 1982	12	107.09	-18.20
July 1980	356.15	October, 1990	3	304	-14.64
March, 2001	1160.33	September, 2002	18	815.28	-29.74
December, 2007	1468.36	March, 2009	15	683.38	-56.52

Note: *End of month.
Source: McCown (2006); NBER; New York Stock and Commodity Exchange.

NBER Business Cycle Peak	Beginning of Yield Curve Inversion*	Beginning of Yield Curve Inversion
December, 1969	December, 1968	February, 1970
November, 1973	June, 1973	November, 1974
January, 1980	November, 1978	April, 1980
July, 1981	October, 1980	September, 1981
July 1990	June, 1989	December, 1989
March, 2001	July, 2000	December, 2000
December, 2007	October, 2006	May, 2007

Note: *Yield curve inversion in this table is defined as a period in which the yield to maturity on a 10-year treasury note is less than the yield on a 3-month treasury bill.

Source: NBER; Federal Reserve Bank of New York

4. Why A Prolonged Sell-Off Upon Yield-Curve Inversion? As remarked by McCown (2007), a coherent and comprehensive explanation of why sell-off is so slow following yield curve inversion has been elusive. Traditional finance theory based on the assumptions of symmetric information and perfect and competitive markets such as the Modigliani and Miller theorem, the CAPM, the EMH and continuous time finance, has difficulties to reconcile with this phenomenon.

Still, Boudoukh, Richardson and Smith (1993) speculated that investors are willing to accept the expected negative returns on stocks because the stocks can be used to hedge fluctuations in their consumption stream. McCown (1999) suggested there is an unknown risk factor, other than consumption, that investors are hedging against by retaining their stocks during the initial phase of a recession.

Another possible explanation is that high stock prices during the adjustment period keep the firm's equity cost of capital low. High stock prices at the secondary market can result in high demand for seasoned offerings, initial public offerings, venture capital, and other private equity placements. High stock prices can also act as a signal to lenders (banks, bond investors etc.) to offer more favorable terms to the companies. This results in a lower cost of capital for firms, and a greater amount of direct business investment during the months following the business cycle peak than would be the case if investors immediately sell off their stocks when the yield curve inverts.

This paper proposes that the conundrum of the delay could also be explained by applying the same concept of "clock game" hypothesis put forward by Brunnermeier and Morgan (2010) which posited that each player at a market plays a waiting game for payoff-relevant signals while predicting the timing of other players' moves. The trade-off in the clock game is between reaping higher profits from moving later versus the possibility of preemption should other players move more quickly. Herding would ensue after any player makes a move as the clocks among players become more synchronized.

Deploying the clock game hypothesis in a macroperspective, a stock market can be seen as an arena for clock game in which interaction between institutional fund managers, policy makers, and domestic fund investors in playing out a game of strategic delaying and strategic preempting of each others' action creates an intense complexity that hinders forecasting accuracy of stock market crashes and hence prolonged sell-offs. This paper hypothesizes that there are essentially 3 phases in a clock game leading to a stock market crash.

At the first stage, the yield curve of 3-month and 10-year treasury bills would inverse. At Stage 2, every major fund manager at a market plays a waiting game with

the hope that no one sells off their portfolio too early. Institutional players always avoid cashing out unnecessarily or too early because of the dividend or interest commitment towards the domestic fund purchasers. In the third phase, there are two possibilities. The first is that fund managers may succumb to the pressure of selling from bottom up when the information of a possible recession finally sinks into the domestic fund investors. The second possibility is straightforward. Central banks, especially the Federal Reserve, intervene and successfully avert a looming recession.

While the clock game is quite complex to analyze, the problem could be transformed to one that can be readily analyzed using auction theory. The equilibrium waiting time in a clock game is structurally similar to the equilibrium bid in a multi-unit reverse first price auction with a stochastic outside option. When moves are unobservable, each player waits a fixed amount of time after receiving a signal before making a move. Slower information diffusion leads to longer equilibrium waiting time. When moves are observable, equilibrium waiting still has the same properties up to the time the first player moves. However, following this, herding occurs and all remaining players make their move immediately.

Theoretically, domestic investors are less savvy and their act not as prompt as fund managers. Before the pressure of selling is induced by end investors, fund managers would hold on to their portfolios for as long as possible. Should any fund manager pre-empt the others and sell off first, signs of sell-off would trigger a reverse bidding at a market. In the meantime, authorities such as the US Federal Reserve would implement monetary expansion to ease the market pressures and attempt to maneuver away from a possible recession. The outcome of monetary expansion is anticipated by institutional fund managers and served as a feedback loop to their waiting game.

5. Limitations of Conventional Modeling Techniques.

Conventional economics has seen itself as a conventional science in which it simplifies the complexity by finding a formal structural analytic model, an equation, or set of equations that fits the data (Colander, 2000). The model is then tested by comparing the predictions of the model with the empirical data, using formal statistical techniques. These models are generally linear and static since they maintain unique, deterministic solutions. To test the models, classical statistical tests are generally used. The process leads to a constant search for theories using new methodologies, which is omnipresent in corporate finance.

Moreover, according to Bernard, assumptions have to be made regarding the class of possible dynamics. Most of the classes used such as Bachelier's dynamics, Black and Scholes dynamics, diffusion models, stochastic volatility models, and GARCH-models are chosen by a rule of thumb, with no real economic justification. These classes of dynamics, under the umbrella of EMH, often conceive the randomness of the prices as completely exogenous, that is, based on the information emerging in the market. Nonetheless, many have shown that stock prices movements are predominantly caused by endogenous factors.

Conventional techniques have disregarded the existence of non-linear dynamics permeates in many facets of the financial markets which are essentially organized as a complex system. The context of financial markets and articulating from the complex system aspect, the feedback of reaction by stakeholders in regards to a stock market forecast would ultimately cancel the potential accurateness of a fore-

cast. As such, in a hypothetical situation should the economy is predicted to undergo a sharp contraction, an expansionary monetary counter-measure undertaken by a central bank to offset the possibility of a downturn may render the forecast null. The creation of cheap credit would feedback into the market and prolong the inflationary spiral of stock prices bubble. In the state of instability where a collapse is imminent, any unfavorable new information that emerges at a market could become the instantaneous cause of market crash when unstable state is untenable anymore.

6. Conclusion. To recap, in the second section, we have looked at some common arguments attempting to explain stock market crashes. In the third section, the discussion detailed some possible signals of recessions, involving stock market crashes and inversion of yield curves. The fourth section delivered the reasons explaining long lag from yield curve inversion to market collapse. The fifth section explored the limitations suffered by conventional econometric techniques in predicting market crashes and recessions.

To conclude, financial markets are highly complex, self-feeding, and responsive to external shocks including rescue packages from fiscal and monetary authorities. For this reason, relatively inexact qualitative approach in explaining and hence predicting market collapses and recessions might be more relevant than the exact approach of quantitative modeling.

References:

Boudoukh, J., Richardson, M., & Smith, T. (1993). Is the ex ante risk premium positive? A new approach to testing conditional asset pricing models, Journal of Financial Economics, 34: 387-408.

Brunnermeier, M.K. & Morgan, J. (2010). Clock games: theory and experiments, Games and Economics Behaviour, 68: 532-550.

Casarin, R. & Trecroci, C. (2007). Business Cycle and Stock Market Volatilities: Are They Related? (Discussion Paper No. 0603) Retrieved from Department of Economics — University of Brescia: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=888524

Chauvet, M. (1999). Stock Market Fluctuation and The Business Cycle, Journal of Economic and Social Measurement, 25(3-4): 235-257.

Colander, D. (2000). A Thumbnail sketch of the history of thought from a complexity perspective, in: Colander, D. (Ed.), Complexity and the History of Economics Thought (pp. 31-44). London: Routledge.

Cooper, G. (2008). The origin of financial crisis. New York: Vintage Books.

Cross, R., Grinfeld, M. et al. (2005). A threshold model of investor psychology, Physica A: Statistical Mechanics and its Applications, 354: 463-478.

Federal Reserve Bank of New York. Yield Curve as a Leading Indicator. Retrieved September 17, 2010, from http://www.ny.frb.org/research/capital_markets/ycfaq.html

Haubrich, J. & Dombrosky, A. (1996). Predicting real growth using the yield curve, Federal Reserve Bank of Cleveland, Economic Review, 1996(1): 26-35.

McCown, J.R. (2007). The Role of Stock Prices in Business Cycle (Working Paper Series 04/02/07). Retrived from: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=961872

NBER (The National Bureau of Economic Research). Information on Recessions and Recoveries, the NBER Business Cycle Dating Committee, and related topics. Retrieved September 16, 2010, from http://www.nber.org/cycles/main.html

New York Stock and Commodity Exchange. Standards & Poor's 500 Index History. Retrieved September 16, 2010, from http://www.nyse.tv/s-and-p-500-history.htm

Shaaf, M. (2000). Predicting recession using the yield curve: An artificial intelligence and econometric comparison, Eastern Economic Journal, 26(2): 171-190.

Shiller, R. (2003). "From efficient market theory to behavioral finance", Journal of Economic Perspectives, 17 (1): 83-104.

Shiller, R. (2005). Irrational Exuberance (2nd ed.). New York: Double Day.

Sornette, D. (2003). Why Stock Markets Crash: Critical Events in Complex Financial Systems. Princeton: Princeton University Press.

Taylor, J.G. (1998). Investment timing and the business cycle. New York: John Wiley & Sons.

White, W. R. (2008). Past financial crises, the current financial turmoil, and the need for a new macrofinancial stability framework, Journal of Financial Stability, 4(4): 307-312.

Wright, J.H. (2006). The Yield Curve and Predicting Recessions (FEDs Working Paper No. 2006-7). Retrieved from Federal Reserve Website: http://www.federalreserve.gov/pubs/feds/2006/200607/200607pap.pdf

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Article entitled "Setting Standards for Green: An analysis of Taiwan green hotel rating program", the CORRECT affiliation of the author Hwai-Shuh Shieh must be: Assistant Professor, Department of Tourism and Hospitality, Kainan University, Taiwan.

We apologize for any inconvenience caused by the misprint.