Equity markets structures and the build-up of endogenous financial fragility in key EU indices: which regulation?

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Abstract

What equity do markets do? Ultimately, they produce prices. This paper, analysing various market models, attempts to show the mechanics of price formation (discovery) processes hence to examine which intervention on markets structures should-could be appropriate in order to set high standards of market quality. The main aim of this work is to verify if, in Minskyan terms, the build-up of endogenous financial fragility is linked to the mechanics of major European capital markets. Proving that link, we argue that an appropriately built market model, paying particular attention to liquidity excesses (surplus or deficit) and their related dynamics of volatility, can reduce the strength of inner market destabilising forces.

Introduction

We argue that proper regulatory interventions on inner liquidity's formation processes and their related volatility dynamics can reduce destabilising equity market dynamics.

The argument is developed in two stages.

First, we show the importance of market mechanics linked to price discovery process, hence the relation between liquidity formation process and volatility dynamics.

Second, we produce empirical evidence of the build-up of endogenous financial fragility linked to the mechanics of key European equity markets.

In order to appreciate the importance of effective market structures linked to price discovery process, we need first to understand a crucial dimension of financial markets: liquidity and its inverse proxy volatility.

According to CAPM, a major pillar of modern portfolio theory, we should not even worry about liquidity and therefore also price discovery process. In fact, CAPM assumptions include:

• No taxes, no transaction costs, and no short-selling restrictions.

• Investors are fully informed hence have the same (homogeneous) expectations about what prices will be in the future.

• Unlimited amounts can be borrowed or lent at a constant, risk-free rate.

• Markets are perfectly liquid.

These assumptions produce a formally elegant model which provides insights into the definition and measurement of risk and return, their relationships, the risk reduction benefits, the pricing relationships between a market portfolio and the risk-free asset, and the market equilibrium. In such perfectly efficient market, information will be reflected in prices with an accuracy that leaves no investor an incentive to search for additional information or to trade. If information is perfectly reflected in prices and if trading is a costless process, then security prices will follow a random walk. In other words, there is no such a thing like a price discovery process.

Unfortunately, the real-world markets are much more complex than CAPM world, so that information is incomplete, expectations are heterogeneous, trading costs are high and related to liquidity. When these factors are taken into account, analysing the dynamic process of price formation becomes considerably complex and high standard for the market architecture are vital for minimising distortions of that process.

The second part of the paper is devoted to empirical analysis on volatility levels. In particular, we show that equity markets become fragile during the so called ‘bull’ phases, when protracted buying pressures quietly build up liquidity excesses and large returns making the long term investors and regulators happy about how the markets work with low volatility levels.

Alternatively stated, we identify endogenous markets mechanics that could help understanding the why and how of this ‘risk taking bubble pattern’.

In order to do so, we focus on the relation between implied volatility levels and bubbles in 3 major EU equity indices over the last decade. In particular, the analysis has been conducted on DAX 30, FTSE 100, CAC 40 and the respective implied volatility indices: VDAX, VFTSE & VCAC,[1] evidence of this relation has been produced following two steps. We have first verified the relation between equity prices and volatility levels, then the equity price dynamics during protracted low volatility levels. Our findings can contribute to explain a typical Minskyan process in terms of maximising equity portfolios’ risk-reward, with unleveraged and/or leveraged financial instruments. In other words, the maximisation process of ‘paper’ profits during low risk market phases produces an endogenous cumulative equity bubble dynamic. Over the analysed periods the 3 EU equity markets show how their fragility evolves dynamically in a self-reinforcing mechanism towards bubbles.

1 These volatility indices are built on the VIX methodology introduced by Whaley (1993). The Appendix II provides a brief explanation of the Vix application.

Price discovery process

The term 'price discovery' identifies the process by which a market finds a new equilibrium after a change in investor demand to hold shares. The process is inherently costly in markets that are less than perfectly liquid.

Information is the input that drives investment decisions and therefore also trading. Security prices are a result (output) of the process. In fact, investment decisions involve portfolio formation and stock selection with respect to longer-term risk and return relationships in an environment where uncertainty dominates participants decisions. Trading involves implementation of the investment decisions and also buying and selling activity to exploit short-run price swings and arbitrage possibilities. That is, price discovery occurs in the marketplace, here it is in more details.

Having to act in an uncertain environment, market participants must base their price forecast on mixing past experience with any new reliable information they can get, so they will form divergent and adaptive expectations. In other words, the uncertainty produces heterogeneity of points of view and strategies of investors. Heterogeneities also come from the strategies of investors linked to different objectives to which their portfolios are constrained. Think for instance to pension schemes and hedge funds. This generally implies different time horizons and reaction functions. These heterogeneities are, however, far from being a stable feature of the markets, where herding behaviours and the search for value may at times overshadow basic strategic differences. Financial markets work, therefore, in a changing environment and with changing heterogeneities. The resulting information inflow is filtered and interpreted, also generating conflicting valuations on the new fair values (computed equilibrium prices). Observable dynamic response of the market depends on the complex interaction among different models and different functions of reaction where each step of the price path is non uniformly interpreted by different market participants. While some of them may consider the price getting closer to its new equilibrium, others propend for an accumulation of disequilibria. Moreover, the specific market dynamics can, over time, lead some market participants to change their view on the level of the new equilibrium.

To get to the point, in an environment where investment and trading decisions are characterised by uncertainty, share values cannot be determined at the desks of security analysts. Rather, prices must be set in the marketplace, where the buy and sell orders of a large set of participants are brought together and translated into trades; where values at which participants transact in the current period depend on the participants' strategic trading decisions: how they price, size, time, and otherwise condition their orders; where the rules and protocols that determine how orders are handled and translated into trades and transaction prices matter a great deal for the dynamic process of price formation.

Basically we have just stated that prices are discovered while trading takes place with its strategy and tactics deeply influenced by the realities of a less than perfectly liquid marketplace.

Liquidity's formation

The literature on liquidity formation is vast, among others: Paroush, Schwartz and Wolf (2008), Hendershott and Moulton (2007), Amihud, Mendelson and Padersen (2005), O'Hara, (2004), Jones C. M. (2002). The terms used in the following discussion are reported in appendix I.

A standard definition of a liquid asset is: an asset that is in cash or that is readily convertible into cash. This is not very clear. How 'readily' can be measured? Is 'readily' costly and if so how much? No easy answers to those questions.

A better approach may be to focus on the depth, breadth and resiliency of a market, which are distinctive aspects of liquidity.

Market's depth and breadth means that orders exist at an array of prices in the close neighborhood above and below the price at which shares are currently trading, and the best buy and sell orders exist in substantial volume, also bid-ask spreads are tight and market impact not significant. Market's resiliency means that temporary price changes due to temporary order imbalances quickly attract new orders to the market to restore reasonable share values. An important implication is that

trades tend to avoid inappropriate prices. Moreover, the tightness of bid-ask spreads and the frequency with which an asset trades are interesting measures of liquidity.

Where does liquidity come from? Ultimately, liquidity forms when market participants with opposite orders , buy and sell, meet at the same time. The procedures used to match these orders and to translate them into trades derive from the architectural structure of a market. The two primary market structures are order driven and quote-driven.
An order-driven market can be organized in two ways: as a continuous market and as a periodic call auction.
In a continuous trading model, a trade is made at any moment when a buy order meets a sell order in price and, on each side of the market, some participants must choose to place limit orders while others must select the market order strategy. In particular, the limit orders, which are entered into a limit order book, establish the prices at which the market orders will execute. The market is order driven precisely because the limit orders placed by some participants set the values at which others can trade by market order. In this environment, the liquidity supply comes from the limit order placers, and the liquidity demand comes from the market order traders. So that, liquidity builds as limit orders are entered in the book, and liquidity is drawn down as market orders trigger trades that eliminate limit orders from the book. Some participants are motivated to be liquidity providers because when the trade is made at the limit price this will be alternatively the best bid or the best ask, but this advantage comes with a cost: there is not certainty to execute a limit order. On the other hand, the market order traders typically will not receive the best bid or ask, but this cost has a compensation: the market order is executed with certainty and immediacy.

Different from a continuous trading is a periodic call auction, in fact, here trades are made at pre-announced moments in time, for instance at the open, at the close or at an pre-established time during the day. Orders entered for a call are held until the call, at which time they are batched together for a simultaneous execution at a single price. By pooling many orders together, a call auction model forms liquidity at predetermined points in time during the trading day.

A very divers structure is the quote-driven market, which is characterised by intermediaries, the market makers who, unlike brokers who only handle customer orders on an agency basis, trade as principals with their customers. So that, in a pure quote-driven market, prices are set only by dealer quotes. In particular, market makers buy shares when public participants wish to sell and sells shares when public participants wish to buy. At any moment, a market maker’s bid quote is lower than his ask quote, and he attempts to profit from buying shares at prices that are lower than those at which he will sell. In other words, market makers profit from the bid-ask spreads, wider the spreads greater the profits and vice-versa.
By posting quotes, market makers bring capital to the market that enables public customers to trade with immediacy. This does not mean, however, that market makers are the fundamental source of liquidity, they simply helps transmit shares from sellers to buyers by interceding in the trades. In this environment as in the order-driven market, the fundamental source of liquidity for public buyers is always public sellers, and the fundamental source for public sellers is always public buyers.

Technically, the liquidity formation is different in each of the three trading mechanisms we have just considered. These mechanisms are being engineered in hybrid market models to deliver a more robust price discovery process. In fact, a pure continuous trading model can break down in a number of circumstances: if a market is thin and order arrival infrequent, if some participants, let's say institutional customers, have very large order size, and/or if a market is under particular stress (think of sensible economic news release). In these cases, structure beyond the limit order book is needed an that may be provided by call auctions and/or market makers.

Market quality

What market quality means and how it can be achieved? As we will briefly discuss, (for an extensive debate on these issues see Schwartz, Byrne and Colaninno (2005), Schwartz and Francioni (2004)), market quality means different things to different participants, but, ultimately, it depends on various exchange features all of which directly affect trading costs and liquidity hence price discovery. In particular: transparency, reliability, consolidation of the order flow, and easy access to a market. The problem is that all these features are complex. For instance, transparency is certainly an objective, but complete transparency should not be pursued in all market models. In intermediated markets, too much transparency can discourage the provision of dealer capital and, in so doing, cause a market to be less liquid. Total or too much concentration of the order flow can result in monopoly power and technological inertia that would undermine a market's incentive to innovate and to adopt new technologies. Even easy access is arguable. Access to a market is possible through an intermediary and directly, it depends on the type of participants etc. The questions are relative to how it could be appropriately provided. Orders can be sent to a market either directly or via another market through linkages. Which works best? How does one even quantify the quality of access?

One could say that trading costs, being higher in less liquid markets, are a reflection of market quality, that is true. But there are issues concerning how readily they can be quantified. Think for instance that even trading commissions are not straightforward because of the widespread use of soft dollars, in Europe are called soft commissions. Trading costs also include bid-ask spreads, market impact and opportunity costs. Bid-ask spreads are observable but may be misleading because trades are commonly made within the spread as orders are price-improved. Market impact and opportunity cost are the most important for large traders, but they are far more difficult to quantify, especially for orders that are broken into smaller tranches and executed over an extended period of time, think of iceberg orders.

All these interesting issues apart, for the sake of our intent, we say that market quality, bottom line, means accuracy of the price discovery process. The more accurate the resulting price discovery the higher the quality of that market structure.

Liquidity and volatility

In light of the difficulties encountered in dealing with the various aspects of market quality, we will focus on one measure, volatility, for an insightful analysis of the link market quality-volatility see Schwartz, Byrne, and Colaninno (2005), Ozenbas, Schwartz, and Wood (2002).

Volatility has its own dark and light sides. The dark volatility levels come from price variations too high and too low, the light ones are those with medium intensity. The light volatility levels, alternatively stated the 'normal volatility', characterize medium intensity price adjustments which are attributable to variations of expectations relative to sensible economic valuations, and this kind of volatility is needed for a correct market functioning, to appropriately compensate limit order trades and broker-dealer intermediaries who are critical liquidity providers. The dark volatility levels are process-driven, characterize price changes that are attributable to transaction costs and market impact due to the arrival of large buy and sell orders. This volatility is manifest in accentuated price swings but also in subdued price variations both in short and longer term. From our point of view a superior market quality is needed precisely because liquidity is critically related to volatility, which comprehends the other determinants of market quality, so that a most serious markets systemic problem is liquidity disequilibrium and its consequent volatility excessive variations. When this occurs, the market's ability to discover price with reasonable accuracy breaks down. As we will see, this analysis requires measuring volatility levels with reference to market's significant dynamic disequilibria in short and long period, think of large bid-ask spreads, market's bubble or crash.

The market microstructure literature has extensively proved the relationship between short-term volatility and trading costs, among others: Hau (2006), Chordia, Sarkar and Subrahmanyam (2005),

Bessembinder and Rath (2002).
Short-period (intraday) volatility tends to be more accentuated when trading takes place with a liquidity deficit, in this case spreads are wide (slippage), execution costs higher and price discovery less accurate.
The slippage size crucially depends on market liquidity conditions, either due to the market's structural characteristics or characterising very short markets phases that are atypical especially for the types of orders and the volume size traded. A further critical aspect of the slippage is relative to shocks that hit the markets. We refer to daily events, as the market openings/closings and the economic news release, but also to less frequent events as the technological crash of an exchange, that determines the block of all transactions till its reopening, or errors in sending abnormal amount of orders to the book. In both cases a significant misalignment of the bid/ask spread is produced and price discovery destabilised.
Execution costs accentuate short-period price volatility as transaction prices bounce between the higher values paid by eager buyers and the lower values received by eager sellers. Price fluctuations that characterize the price discovery process can be further destabilizing if they cause investors to lack confidence that a price level is reasonable. At times, if some participants rush their sell orders to market and others step away with their buy orders, price can drop precipitously. At other times, some may rush their buy orders to market while others step away with their sell orders, and price can rise precipitously. When this happens, an extreme bout of volatility can occur. Because the volatility accentuation is largely a short-run phenomenon, short-run volatility is a good (inverse) proxy for liquidity. Also important to note is that short-run volatility, which is reflective of execution costs and the complexities of price discovery, can be most effectively brought under control by improving the systems used for handling orders and translating them into trades. To sum up, the liquidity of a market and its related volatility depends not only on the characteristics of an asset being traded, its market cap, investor characteristics whether institutional or retail, and exposure to informational change, but also on the architectural structure of a market where the asset is traded because it deals with an array of factors, for instance, patterns of news release, whether corporate and government announcements tend to be made in the overnight halt or during the trading day. Moreover, intraday trading patterns of institutional investors, whether or not the big players tend to avoid trading at the open, the cross-listing of stocks in markets with overlapping time zones and the amount of after-hours and preopen trading.

The longer-term volatility analysis is the object of our empirical study. Longer-term (daily) volatility tends to be subdued when trading takes place with liquidity excess. In this case, market price discovery, in a trading environment dominated by large participants, may result in periods of protracted buying or selling pressure. Our empirical findings will show the naturally inverse relation between protracted buying pressures and implied volatility measures, the VIX, and its consequences on markets dynamics.
A well-functioning equity market should provide reasonable price and quantity discovery for all participants, retail and institutional, but this task is not simple. One reason is precisely that institutional investors are reluctant to participate actively in market price discovery, actually they seek invisibility. Institutional investors' orders are commonly huge and can impact market prices, especially those from large mutual funds and banks, hence they prefer to trade with scarce transparency and low volatility. This is not a new phenomenon. Academic research in this area is considerable, among others: discussion by Wayne Wagner, in Schwartz, Byrne and Colaninno, (2005). Persaud (2002), Welch (2000).
Briefly stated, these institutions, with the exception of some active investment funds, have very strong incentives in pursuing that strategy: to avoid the significant costs related to trading with an higher volatility and to disclosing their orders. Think for instance to executing a large buy order at the highest ask or having an active role in the price discovery process, as a consequence, they hold back orders, even at prices that would be market-clearing values. No buy side equity trader wants to purchase 30,000 shares of a stock at $50 and then see price drop to $49.75 on a 500-share sell order.

A liquidity level insufficient to maintain the price is a compelling reason for institutions to avoid playing a leadership role with respect to price discovery.
In this environment, protracted buying or selling pressures can develop when large institutional participants and/or informed traders break up their trading in a stealthy fashion for partial execution over a series of trades (iceberg order). Of course, this can happen for various reasons, for instance to control market impact costs, to hide trading strategies linked to new price valuations etc., but all have one thing in common: the level of liquidity and its inverse proxy volatility. Accordingly, the second phase of this research is devoted to empirical analysis on volatility levels. In particular, we show that equity markets become fragile during the so called 'bull' phases, when those protracted buying pressures quietly build up liquidity excess and large returns making the long term investors and regulators happy about how the markets work with low volatility levels.
Alternatively stated, we identify endogenous markets mechanics that could help understanding the why and how this 'risk taking bubble pattern'.
In order to do so, we focus on the relation between implied volatility levels and bubbles in 3 major EU equity indices. In particular, the analysis has been conducted on DAX 30, FTSE 100, CAC 40 and the respective implied volatility indices:VDAX, VFTSE & VCAC, evidence of this relation has been produced following two steps.

We have first verified the relation between equity prices and volatility levels, then the equity price dynamics during protracted low volatility levels.

Given data availability, we have run regression analyses over the last decade, evidencing the 2003-2006 sub-period, since during that period the equity prices have shown a sharp run up and the volatility indices the steadiest and steepest drop to all time lows.

Particularly interesting in our view is that our findings can contribute to explain a typical Minskyan process in terms of maximising equity portfolios' risk-reward, with unleveraged and/or leveraged financial instruments. In other words, the maximisation process of 'paper' profits during low risk market phases produces an endogenous cumulative equity bubble dynamic. Over the analysed periods the 3 EU equity markets show how their fragility evolves dynamically in a self-reinforcing mechanism towards bubbles.

Empirical Analysis

The CBOE (2003) methodology for computing the VIX index is not unique to the prices of S&P 500 index options. It can be applied to any index option market. The important requisite, as stated above, is that the underlying index option market has deep and active trading across a broad range of exercise prices.
In fact, the main European equity markets adopt the VIX methodology to provide a benchmark of expected short-term market volatility. Next we analyse the relation between DAX 30, FTSE 100, CAC 40 and the respective implied volatility indices.

VDAX relation to the DAX 30 Index

We regress, over the period (01-03-2000/30-07-2009), the daily rate of change of the VDAX, *RVDAX* , and the daily rate of change of the Dax Index, *RDAX* ,

$RVDAX= a+ bDAX+e$

that is:

$RVDAX=0.0011-1.897\ RDAX$

The number of observations is 2437 and the regression Adjusted R-squared 43.7%.

The intercept in the regression is 0.0011, this means that if the DAX does not change over the day, the rate of change in VDAX should be negligible.

The estimated slope coefficient is negative and significant. If the DAX rises by 100 basis points, the VDAX will fall by 1.89%.

Over the sub-period (02-01-2003/28-12-2006) we obtain:

$RVDAX=0.0018-2.457\ RDAX$

The number of observations is 1020 and the regression Adjusted R-squared 49%.

If the DAX rises by 100 basis points, the VDAX will fall by 2.45%.

VFTSE relation to the FTSE 100 Index

Over the same period (01-03-2000/30-07-2009) we regress the daily rate of change of the VFTSE, *RVFTSE* , and the daily rate of change of the FTSE Index, *RFTSE* , that is:

$RVFTSE=0.0016-3.073\ RFTSE$

The number of observations is 2458 and the regression Adjusted R-squared 41%.

The intercept in the regression is 0.0016, this means that if the FTSE does not change over the day, the rate of change in VFTSE should be negligible.

The estimated slope coefficient is negative and significant. If the FTSE rises by 100 basis points, the VFTSE will fall by 3.07%.

Over the sub-period (02-01-2003/28-12-2006) we obtain:

$RVFTSE=0.0024-4.25\ RFTSE$

The number of observations is 1023 and the regression Adjusted R-squared 45%.

If the FTSE rises by 100 basis points, the VFTSE will fall by 4.25%.

VCAC relation to the CAC 40 Index

Again over the same period (01-03-2000/30-07-2009) we regress the daily rate of change of the VCAC, *RCAC*, and the daily rate of change of the CAC Index, *RCAC*, that is:

RVCAC=0.0014-2.053 RCAC

The number of observations is 2471 and the regression Adjusted R-squared 30%.

The intercept in the regression is 0.0014, this means that if the CAC does not change over the day, the rate of change in VCAC should be negligible.

The estimated slope coefficient is negative and significant. If the CAC rises by 100 basis points, the VCAC will fall by 2.053%.

Over the sub-period (02-01-2003/28-12-2006) we obtain:

RVCAC=0.0021-3.11 RCAC

The number of observations is 1024 and the regression Adjusted R-squared 43.8%.

If the CAC rises by 100 basis points, the VCAC will fall by 3.11%.

VDAX, VFTSE & VCAC normal and abnormal Low levels

In order to study the equity price dynamics during protracted low volatility levels, we attempt to characterize what is normal and abnormal Low level of Vdax, Vftse and Vcac.

The percentile analysis presented in table 1 allows us to define as normal levels for these volatility indices the closing between 28 and 20 index points, and as abnormal Low level the closing below 17 index points.

To asses the relations between Vdax, Vftse and Vcac normal and abnormal Low levels and the relative equity indices we consider those levels significant only when the volatility indices remains below the abnormal lows for 6 consecutive months at least.

Table 1 Percentile analysis of Volatility Indices

		VDAX	VFTSE	VCAC
N	Valid	2437	2458	2471
Percentiles	5	12.6580	10.7866	12.7973
	10	13.8480	11.8063	13.8043
	25	16.9050	14.3518	17.0554
	50	21.4200	19.6494	22.2731
	75	27.3100	26.1730	27.6675
	90	40.3740	35.9181	39.7292
	95	45.8210	41.7930	46.4300

Source: Eurex monthly statistics, Nyse Euronext Back history, Reuters.

Table 2 VDAX relation to DAX bubbles

Period –consecutive months below the abnormal Low level-	Delta Dax
03-11-2004/12-05-2006	34.21%
21-08-2006/05-06-2007	27.95%
Period –consecutive months within the normal levels-	
21-11-2001/10-06-2002	-10.44%

Source: Eurex monthly statistics, Reuters.

Table 3 VFTSE relation to FTSE bubbles

Period –consecutive months below the abnormal Low level-	Delta FTSE
03-11-2004/12-05-2006	22.70%
21-08-2006/05-06-2007	10.81%
Period –consecutive months within the normal levels-	
21-11-2001/10-06-2002	-7.80%

Source: Nyse Euronext Back history (01/2000- 23/07/2008), Reuters.

Table 4 VCAC relation to CAC bubbles

Period –consecutive months below the abnormal Low level-	Delta CAC
03-11-2004/12-05-2006	39.87%
21-08-2006/05-06-2007	20.00%
Period –consecutive months within the normal levels-	
21-11-2001/10-06-2002	-11.69%

Source: Nyse Euronext Back history (01/2000- 23/07/2008), Reuters.

Tables 2,3,4 show that when these volatility indices persistently remain below ‘abnornal low’ levels (17 Index points) the respective equity Indices ‘go to bubbles’.

On the other hand, when the volatility persistently remains within ‘normal’ levels (20-28 Index points) the respective equity Indices ‘do not go to bubbles’.

It appears that protracted low volatility (under-priced risk) market phases, expressed by implied volatility indices, are a significant aspect of equity indices bubbles.

Protracted low volatility levels relation to key EU equity indices bubbles.

Here, we introduce the analysis of the main implications of the empirical evidence showing that protracted low volatility market phases are a recurrent aspect of bubbles in 3 major EU equity indices. It should be noted that the previous empirical evidence is just a first step since the relation between low volatility levels and equity bubbles is more complex. For instance, the frequency of volatility variations and related demand for equities and/or derivatives affects the characteristics of the ‘risk taking bubble pattern’ as we have defined it.

Nonetheless, these findings can contribute to explain a typical Minskyan process in terms of maximising equity portfolios’ risk-reward, with unleveraged and/or leveraged financial instruments . In other words, the maximisation process of ‘paper’ profits during low risk market phases results in an endogenous cumulative equity –unleveraged- bubble dynamic. Over the analysed periods the 3 EU equity markets show how their fragility evolves dynamically in a self-reinforcing mechanism towards bubbles. In fact, protracted low implied volatility periods lead to higher equity prices, that, in turn, lead to even lower volatility, lower risk premiums, higher volumes (liquidity) and asset prices setting a prolonged and steady equity growth which eventually

feedback into higher profits and even higher risk-taking via increased volumes. This appears as a self-validating process of a significant equity overvaluation that, at some point, must be corrected accordingly to the actual growth rate of the traded sectors. In this regard, the link between abnormal Low level of Vdax, Vftse and Vcac and the related behaviour of the respective equity indices shows a critical endogenous instability.

The process just described interacts with several crucial nodes of the financial system to be further investigated. Among them, the increased usage of leveraged instruments and VAR levels of Institutional Investors. At this stage, we can introduce preliminary considerations on the increased usage of leveraged instruments. Equity option sellers, the so called 'writers', have an incentive to sell an increasing volume of options during low volatility market phases. This is because writing any option will have a high probability of gaining premiums as the low volatility will take the options to expiration without being exercised.

Table 5 shows the VDAX relation to DAX Options volumes (traded). Given data availability we have run the analysis only on the DAX Option volumes during the period 01/01/1995-31/12/2008.

When the Vdax persistently remains below 'abnormal low' levels (17 Index points) the DAX Options volumes increase significantly compared to periods when VDAX remains within 'normal' levels (20-28 Index points).

Table 5 VDAX relation to DAX Options volumes traded

Period -consecutive months below the abnormal Low level-[2]	Delta Dax Options Volumes	Delta Vdax – closing-	High-Low range Vdax – including spikes-
13-04-1995/07-02-1997	Incomplete data	-1.7%	15.94/10.1
12-11-2004/05-05-2006	71.25%	-4.5%	16/10.96
Period -consecutive months within the normal level-			
01-04/1999/31-08/2001	35.22%	5.04%	31.40/16.86

Source: Eurex Monthly Statistics Derivatives Market

Accordingly, it is possible to affirm that there is a clear nexus between the 'abnormal low' volatility levels and traded volumes of Dax Index options (Calls and Puts), in particular, protracted low volatility phases, expressed by Vdax, are a significant aspect of increased leverage in this market. Again, as discussed above, this is a typical Minskyan process in terms of maximising portfolios' risk-reward with leveraged financial instruments. In fact, the maximisation profit incentive tends to increase the option volumes 'written' by institutional investors, which means that their leverage exposure lifts up requiring stable low volatility levels in order to keep up the premiums inflow. Eventually these leveraged positions could become fragile so that a light volatility increase could cause their default.

EU market models, volatility levels and regulations

The complexities discussed reduce the accuracy of the price discovery process and deeply impact on markets dynamics so they need to be reasoned in an appropriate market model. Given the characteristics of the primary market structures, we can say that more than one trading mechanism is needed for accurate price discovery. With regard to short-period volatility a lot has already been done by major EU exchanges. in Frankfurt, London and Paris hybrid market models are in place, along with continuous trading, call auctions are used to focus liquidity at critical points in time during the trading day. Calls are being used to open and to close those markets. To further facilitate price discovery, Deutsche Borse currently runs three call auctions a day in Xetra: one at the open,

2 The sub periods do not coincide with those of tables 1,2,3 because of data gaps.

one at the close, and one intraday. Comprehensively viewed, call auctions in Europe are thought to be working well (Schwartz, Byrne and Colaninno (2003)). Furthermore, one kind of market maker in particular, referred to as designated market maker (in Germany) and liquidity provider (in France), plays a particularly important price discovery role for the less liquid securities. Additionally, Deutsche Borse, on 12 October 2009, has adopted an innovative trading model, the 'Continuous Auction with Specialist' addressed to companies that are currently traded in One-Auction Only on Xetra (Deutsche Borse Group (2009-2010)). However, it should be noted that these agents play no role at all for the large-cap securities, as the DAX 30, FTSE 100, and CAC 40 stocks are thought to be sufficiently liquid without them. This is evidencing that there the problems come from liquidity excess.
To further enhance short-period price stability, Frankfurt, London and Paris adopt an extremely interesting form of circuit breaker: volatility interruptions. This mechanism halts trading for short periods when intraday price changes exceed certain critical thresholds. A volatility interruption in Germany's Xetra lasts for about 2 minutes with the aim to deliver a check against errors in order entry, to enable liquidity to be focused and price discovery sharpened when the halt ends. The market reopens using the call auction procedure.

With regard to longer-period volatility our analysis is still in progress, nonetheless, some interesting considerations can be drawn. For instance, given the trading needs of institutional investors it seems that their trading techniques, during protracted low volatility phases, actually lead to a typical Minskyan process deeply impacting on financial bubbles formation. Additional study on institutional order flows could give more insight on which type of institutional investors trade the heaviest equity volumes during those low volatility phases.

Besides, our research suggests that hybrid market structures are needed to deliver a more robust price discovery process in short and long term. In particular, hybrid models should also be engineered to control extremely low longer-period volatility levels. Technically, as the liquidity formation builds up, because of protracted institutional buying pressures, daily volatility levels decrease, then, according to our findings, at the sixth consecutive month of 'abnormal low' volatility should be adopted a daily volatility interruption. This circuit breaker mechanism should halt trading for an entire trading session with the aim to provide a market check against liquidity excess and to restore a more accurate price discovery. This is meant to avoid that markets participants keep fuelling buying pressures simply because others are buying or because the 'abnormal low' volatility is favouring the placement of very large orders. When the halt ends, the market should reopen using the call auction procedure.
Naturally, a more extensive empirical study should include markets different than equity and run simulations on the impact of this circuit breaker mechanism, one possibility would be to focus on measuring liquidity formation (via volume traded) ex ante and ex post the halt.
Provided that this additional analysis will confirm the above results, it should be possible to build a dynamic indicator of financial fragility useful as an additional tool to study 'exuberant' financial markets phases.

Appendix I
Placing orders

To ensure consistent, transparent price determination, an exchange's algorithm can accept only two order types: limit orders and market orders. Other orders, the conditional orders, must be handled outside of the matching model, typically in the front ends of members. To be entered into the matching procedure of an electronic order book, all conditional orders must be converted into either market or limit orders. However, specialists on a trading floor offer a special service to deal with conditional orders by taking them on their own books. One special order type can be placed in the book, however. It is an iceberg order. On the other hand, unconditional orders are always acceptable for a direct match. These orders indicate at market, or a limit price, and the period for which an order is valid.

Quotation. The price at which someone is willing to buy or to sell shares and the number of shares that he wishes to trade.

Bid Price (buy price). The price at which someone is willing to buy shares. The best market bid is the highest quoted bid of all competing market makers to buy a particular stock at any given time.

Ask Price (offer price). The price at which someone is willing to sell shares. The best market ask is The lowest quoted offer of all competing market makers to sell a particular stock at any given time.

Market bid-ask spread. The difference between the price at which a market maker is willing to buy a security (bid), and the price at which the firm is willing to sell it (ask). The spread narrows or widens according to the supply and demand for the security being traded. The market spread is sometimes referred to as the 'inside spread/quote' or as the best bid and offer (BBO).

Individual bid-ask spread. The difference between the bid and ask quote of an individual participant (typically a dealer) who will both buy and sell shares (i.e., make a two-sided market).

Iceberg order. With an iceberg order, only a small part of an order is shown in the exchange's open limit order book, while the larger part is hidden. As executions are realized, successive parts of the iceberg order are entered in the open book.

Market order. An order to buy or sell a stated amount of a security at the best possible price at the time the order is received in the marketplace. Market orders to buy are typically executed at the best (lowest) quoted ask, and market orders to sell are typically executed at the best (highest) quoted bid.

Limit order. An order to buy or sell a security at a customer-specified price. The limit price on a buy limit order specifies the highest (maximum) price a buyer is willing to pay, and the limit price on a sell limit order specifies the lowest (minimum) price a seller is willing to receive. Limit orders that are posted on a market, if sufficiently aggressive, establish the best market quotes and thus the market's bid-ask spread.

Slippage: it occurs when the bid/ask spread is more unfavourable for at least one tick beyond the standard spread indicated in the exchange's product sepcifications.

The following are special order types that cannot be included in a transparent electronic limit order book.
An all-or-nothing order. An order to buy or sell the entire number of shares stated on the order or, if this is not possible, to buy or sell nothing at all.

Cross-price-conditioned order. An order to buy or sell, for example, 300 shares of x at 50 if the price of y is 30 or higher or lower.

Fill-or-kill order. This is an instruction to execute the order immediately, otherwise cancel it.

Stop-loss order. A customer order to a broker that sets the sell limit price of a stock below the current market price, therefore protecting profits that have already been made or preventing further losses if the stock drops. This order is generally placed as a limit order and it is executed as a market order.

Appendix II
A brief note on the VIX methodology

The VIX is the Chicago Board Options Exchange (CBOE) Volatility Index, which shows the market's expectation of 30-day volatility. It is computed on a real-time basis throughout each trading day.
The first Vix, introduced by the CBOE in collaboration with Whaley in 1993, was a weighted measure of the implied volatility of eight S&P 100 at-the-money put and call options. In 2003, CBOE in collaboration with Goldman Sachs updated the Vix calculation to use options based on a broader index, the S&P 500. This is because the SPX is much more liquid than OEX. Currently, SPX options trade about 12.7 times as frequently as OEX options. A real time and meaningful implied volatility index calculation requires prices from an active underlying index option market. Moreover, the new Vix also include out-of-the-money options, in particular, out-of-the-money put prices contain information regarding the demands for portfolio insurance, hence, market volatility.

The Vix is meant to be forward looking and it is quoted in real time in percentage points. This translates into the expected movement of the S&P 500 index over the next 30-day period, on an annualised basis. For example, if the Vix is at 15 index points, it indicates an expected annualised change of 15% over the next 30 days. That is, index options are priced with the assumption of a 68% likelihood (one standard deviation) that the variation of the S&P 500' 30-day return will be within 4.33% (up or down).

Given that volatility is one of the factors used to calculate the value of these options, higher (or lower) volatility of the underlying security makes an option more (or less) valuable, since there is a greater (or smaller) probability that the option will expire in the money (i.e. with a market value above zero). Ceteris paribus, a higher option price implies greater volatility.

The Vix is a widely used measure of market risk, and it is generally accepted that a high value of Vix translates into a greater degree of market uncertainty, while a low value of Vix is consistent with greater stability.

References

Amihud Y., Mendelson H., Padersen L. H. (2005), *Liquidity and Asset Prices, Foundations and trends in Finance*, Now Publishers Inc.

Bessembinder H., Rath S. (2002), 'Trading costs and return volatility: evidence from exchange listings', *working paper, University of Utah*.

Chicago Board Options Exchange (2003), 'VIX: CBOE volatility index' *Working paper, Chicago.*

Chordia T., Sarkar A., Subrahmanyam A. (2005), 'An empirical analysis of stock and bond market liquidity', *Review of Financial Studies,* vol.18, Issue 1, pp. 85-129.

EXTRA-Deutsche Borse Group (2009), Factsheet Expert Model.

EXTRA-Deutsche Borse Group (2010), Market Model Equities.

Hau H. (2006), 'The role of transaction costs for financial volatility: evidence from the Paris Bourse', *Journal of the European Economic Association,* vol. 4, no. 4, pp. 862-890.

Hendershott T., Moulton P. C. (2007), 'The Shrinking New York Stock Exchange Floor and the Hybrid Market', *University of California, Berkeley, Haas School of Business, working paper series*.

Jones C. M. (2002), 'A Century of Stock Market Liquidity and Trading Costs*', working paper, Columbia University.*

Minsky H.P. (1982), *Can "it" Happen Againg?: Essays on instability and Finance,* (N.Y), Sharpe, Armonk.

Morris S. and Shin H.S. (2004), 'Liquidity Black Holes', *Review of Finance* 8, pp. 1–18.

O'Hara M. (2004), *Market microstructure Theory,* Blackwell Publishing ltd.

Ozenbas D., Schwartz R. A., Wood R. a. (2002), 'Volatility in U.S. and European Equity Markets: An Assessment of Market Quality', *International Finance,* vol. 5, no. 3, pp. 437–461.

Paroush J., Schwartz R. A., Wolf A. (2008), 'Dynamic Price Discovery in a Divergent Expectations Environment', *Baruch College, working paper series*.

Persaud A. (2002), 'Liquidity Black Holes And Why Modern Financial Regulation in Developed Countries is making Short-Term Capital Flows to Developing Countries Even More Volatile' *WIDER, Discussion Paper No. 2002/31.*

Schwartz R. A., Byrne J., Colaninno A. (2005), *A Trading Desk's View of Market Quality,* Kluwer Academic Publishers.

Schwartz R. A., Byrne J., Colaninno A. (2003), *Call Auction Trading, New Answers to Old Questions*, Kluwer Academic Publishers.

Schwartz R. A. , Francioni R. (2004), *Equity Markets in Action: the fundamentals of liquidity, market structure & trading*, Wiley and Sons.

Sharpe W. F. (1964), 'Capital Asset Prices: A Theory of Market Equilibrium', *Journal of Finance*, vol. XIX, no. 3, pp. 425-442.

Welch I. (2000), 'Herding among security analysts', *Journal of Financial Economics 58,* pp. 369-396.

Database:
Bloomberg.
Eurex monthly statistics: Vdax.
Nyse Euronext Back history (01/2000- 23/07/2008): Vftse, Vcac.
Reuters.