Microstructure of financial and money markets: lessons learned from the conference held in Paris on 6 and 7 June 2006

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The characteristics of trade and the efficiency and stability of markets depend on how such markets are organised. Market microstructure, which analyses this linkage, is an area of research that has grown extremely rapidly over the past years. However, progress has essentially been made with regard to financial markets. The few articles devoted to the money market are either descriptive (and most often applied to the case of the United States), or based on data whose frequency is insufficient to capture certain stylised facts.

For central banks, it is essential to have a good understanding of the practices and the organisation of financial and money markets, in particular the way in which they respond to monetary policy impulses. From a financial stability perspective, an in-depth understanding of market practices makes it possible to identify new categories of risk, such as short-term risk. In June 2006, the Banque de France organised in partnership with the Center for Research in Economics and Statistics (CREST) and the Europlace Institute of Finance (EIF), a conference on the microstructure of markets, and notably that of money markets.

This conference brought together researchers from central banks, French and foreign universities and renowned research centres. Robert Engle (New York University, Nobel prize 2003) and S. "Vish" Viswanathan (Duke University) presented two invited conferences, and Thierry Foucault (HEC Paris), Joël Hasbrouck (New York University) and Suresh Sundaresan (Columbia University and Federal Reserve Bank of New York) participated in the closing roundtable. The discussions spanned a wide variety of topics that have attracted much attention over recent years: risk measures, the quality of financial markets, the structure of financial and money markets, etc.

This summary first discusses the two invited conferences and the closing roundtable co-organised by the Banque de France. It then highlights a number of issues relevant to central banks, but does not give an exhaustive review of the different topics covered over the two-day conference in view of their variety and their often high level of analytical content. These issues fall into three main areas:

- realised volatility;
- microstructure of the money market;
- comovement, risk and financial stability.

1| INVITED CONFERENCES AND THE ROUNDTABLE

1|1 Invited conferences

In the opening lecture, Professor Engle proposed a measure of transaction costs taking account of the timing and speed of order execution. This measure makes it possible to assess the impact of the different order execution strategies (immediate execution or staggered orders) on the cost and the risk related, *inter alia*, to price changes. It differs from the traditional indicators that do not take into account the cost of a possible change in prices over the order execution time. Analysing orders can therefore be equated with a cost/risk trade-off problem comparable to a mean/variance type study.[1] This study is original from four points of view: it breaks down the transaction cost and its assessment obtained using extremely fine data; it uses an econometric model that explains this cost (mean and variance equations); it proposes a single analysis framework of the behaviour of the trader based on a cost/risk trade-off; lastly, it results in the calculation of a liquidation cost indicator comparable to the value-at-risk (VaR).

The preliminary results are based on US data, and more specifically on orders collected by Morgan Stanley.[2] They show that:

- the immediate execution of orders generates higher costs than those associated with gradual trading; however, in the case of the latter the risks are higher;
- the cost/risk trade-off depends on the state of the market and the characteristics of the order;
- in order to assess liquidation risk it is necessary to estimate the transaction cost equation.

This exercise appears difficult to reproduce for European markets given the lack of availability of relevant data series. Furthermore, the functional form used for the transaction cost assumes that the cost is always positive. This point is questionable given that the transaction cost is defined as a price spread.

In his lecture, Professor "Vish" Viswanathan presented the empirical tests of the theoretical models generally discussed in the literature. More specifically, his lecture focused on the following topics:

- the influence of market returns on liquidity;
- the impact of large variations in market returns on liquidity comovements;[3]
- contagion during periods of declining liquidity. The main liquidity indicator used by Professor "Vish" Viswanathan is the bid-ask spread. A number of tests were carried out with other measures of liquidity (proportional effective spread, etc.) that corroborate, in general, the results obtained with the bid-ask spread.

The most salient results of the study are:

- lagged market returns have a significantly negative impact on liquidity;

1 *This talk is based on two papers that are currently being completed. Robert Engle and his co-authors did not wish to distribute them but they should be accessible on their website after publication of this article.*
2 *As the speaker does not wish to make his empirical results public for the moment, only a qualitative description of the main conclusions is given here.*
3 *Fluctuations in the levels of market liquidity are interrelated.*

• the impact of past negative market returns on liquidity is more pronounced than that of positive returns, the response therefore appears to be asymmetric;

• stock liquidity is more sensitive to changes in market returns for small capitalisation stocks; past returns have a more marked impact on the liquidity of higher volatility stocks;

• negative market returns with a high absolute value reduce the liquidity of all stocks and increase liquidity comovement;

• the comovement in liquidity is due to the changes that affect both liquidity supply and demand; empirical studies often focus on the demand effect, but this does not explain the asymmetric responses mentioned above.

Some results are questionable such as the low significance of some coefficients, the *ad hoc* nature of some relationships, the low explanatory power of some models, etc. However, the empirical findings are in line with the expected theoretical results. Furthermore, this exercise could be reproduced for the case of European markets for example.

1|2 Roundtable

Professor Foucault's lecture centred on the competition for order flow and best execution. He focused on two issues:

• what is the effect of increased market fragmentation on market liquidity?

• Do investors get the best possible execution for their orders in multi-market environments? These questions are of interest to, among others, bodies charged with regulating or supervising markets. After highlighting a number of facts (the close relationship between intermarket competition and best execution; the controversy over the qualities of certain order execution procedures, *e.g.* a centralised limit order book; the inefficiency of some procedures leading to trade-throughs), the author discussed a European experiment: LSE *versus* Euronext. He then put forward a model estimated using European data in order to respond to the two issues raised. In conclusion, he noted that:

• competition between pure limit order books results in a more liquid environment that centralisation;

• best execution rules affect the intensity of intermarket competition; the existence of trade-throughs may reflect a co-ordination problem in adopting new technology and/or agency problems.

Professor Sundaresan focused his lecture on the microstructure of US money markets. Particular attention was given to the role of the Federal Reserve and the US Treasury. The Federal Reserve has almost certainly contributed to the decline in the volatility of short-term money market rates, in particular of the Fed funds rate, by intervening more frequently on the money market through tenders and by offering standing facilities. The corresponding interest rate is a cap on daily repo rates.

In August 2005, the US Treasury announced that it was exploring the concept of a securities lender of last resort facility, making available a supply of securities in the event of markets coming under pressure. This announcement came in the wake of failures to deliver US Treasuries, in particular following the terrorist attacks of 11 September 2001 and in the second half of 2003; between August and mid-November 2003, negative rates were recorded on a number of government securities repurchase agreements. Indeed, too many failures of this type could eventually cause investors to turn to other securities, with detrimental effects for the liquidity of the Treasuries market.

Lastly, Professor Hasbrouck analysed transparency through the role of dealers and the interaction of the primary and secondary markets. He also made a brief comparison of the US and European regulatory frameworks (MiFID[4] and Reg NMS[5]). He postulated that banks generally operate as dealers in opaque markets but regulatory forces favour transparency. This increased transparency should reduce the market power of banks as dealers and raise trading volumes and net profits.

4 *Market in financial instruments directive.*
5 *Regulation national market system.*

Furthermore, the results of theoretical models used to study transparency may lead to recommendations that are contingent on the market situation: in centralised floor markets, trade reporting rules were adopted before external regulation; however, when the market is more physically dispersed, it is more difficult or even more inefficient to enforce trade reporting at a predetermined frequency. After discussing the similarities and differences between the two regulatory frameworks, Professor Hasbrouck finished his lecture with two open questions:

- does Reg NMS indicate the direction of future European regulation?

- Will MiFID transparency enhance European equity markets so clearly that the Commission can extend them to bonds and other securities?

2| REALISED VOLATILITY

In finance and financial econometrics, it is essential to analyse changes and volatility in asset prices. Volatility plays a key role in valuing derivatives, allocating assets and managing risk. More specifically, in order to describe the efficient price process on an asset market, it is necessary to take into account "local" volatility that measures the risk associated with instantaneous variance of the asset price. The problem is that volatility is a continuous, random and unobservable variable.

2|1 Summary of the articles

Following Merton (1980), given the random nature of volatility, researchers no longer focused directly on instantaneous volatility but on integrated variance or quadratic variation which represents the sum (the integral using a continuous-time model) of the squared instantaneous volatility. Integrated variance thus corresponds to the variance of a price over one day, obtained using intraday data (*i.e.* high frequency, 5, 10 or 30 minutes for example). Several approaches have been developed to determine a reliable and robust estimator of integrated variance.

Parametric approaches are based on the use of models that describe the dynamic pattern of the variance of returns. The autoregressive conditional heteroscedasticity (ARCH) model introduced by Engle in 1982, which consists in jointly estimating the return and conditional volatility equations of an asset and, in particular, one of its generalisations (the exponential ARCH model of Nelson, 1992) are serious contenders for measuring integrated variance. Nelson's model has the huge advantage of making it possible to move relatively easily from continuous time to discrete time; consequently, it can be integrated in the analytical framework of continuous-time models in finance. Over the past few years the use of these models has increased significantly, especially in academic circles. The papers presented at the conference are based on this approach.

Conversely, realised variance (or again notional variance) is derived from a nonparametric approach. The realised variance of the price of an asset at date t (one day for example) is the sum of the observed squared returns at a given time step. It is a usual estimator of integrated variance, introduced by Merton in 1980 and discussed further in a number of recent studies (Andersen, Bollerslev, Diebold and Labys, 2001 and 2003; Bandorff-Nielsen and Shephard, 2001, 2002a, 2002b, 2005; as well as Comte and Renault, 2001). In theory, the smaller the time step, the more the realised variance should be a reliable indicator or converge to the integrated variance. Unfortunately, financial asset prices, more particularly at high frequencies, are subject to a very wide variety of frictions that we can interpret as imperfections of the trading process or microstructure effects such as differences in trade sizes or informational content of price changes, the strategic component of the order flow, inventory control effects, discreteness of data, etc. Owing to the existence of microstructure effects the efficient price is not observed. In fact, the observed price is the sum of the unobserved efficient price and a random variable that represents the microstructure effects. Therefore, the usual realised variance estimator is biased and inconsistent. Consequently, a consistent integrated volatility estimator must be determined using noisy data.

Box

Realised volatility

Specific techniques are required to model volatility. The approach put forward in this box is based on an estimate of realised volatility obtained from high-frequency data samples.

A number of recent studies, Andersen, Bollerslev, Dielbold and Labys (2001 and 2003) and Zhou (1996) and Corsi et al. *(2001) among others, have stressed the importance of using the information contained in high-frequency data to calculate volatility. This basically consists in estimating the daily volatility of an asset (integrated volatility) using intraday observations. The integrated volatility, estimated by the sum of intraday squared returns, is also referred to as realised volatility. More precisely, let* p_t *be the price of an asset described by a continuous-time process and characterised by the equation:*

$$d\log(p_t) = m_t dt + \sigma_t dW_t$$

where $d\log(p_t)$ *is the first order difference of the price,* dW_t *a standard Brownian motion,* m_t *the drift and* σ_t *the instantaneous volatility.*

If t *represents a day and* h*, a time step (a real such as* 1/h *is an integer, 5 seconds for example), the realised volatility,* $RV_t(h)$ *is defined by:*

$$RV_t(h) = \sum_{i=1}^{1/h} r_{t-1+ih}^{(h)2}$$

where $r_{t-1+ih}^{(h)}$ *is the return on the asset over a period corresponding to one time step* ($[t-1+(i-1)h\ ;\ t-1+ih]$)*, thus:*

$$r_{t-1+ih}^{(h)} = \log\left(\frac{P_{t-1+ih}}{P_{t-1+(i-1)h}}\right)$$

When h *tends towards 0,* $RV_t(h)$ *converges under certain conditions towards the integrated volatility* IV_t *defined by:*

$$IV_t = \int_{t-1}^{t} \sigma_u^2 \, du$$

It may be tempting to choose the smallest possible time step h *in order to move closer to situation of convergence towards integrated volatility. However, the estimator obtained would be highly contaminated by microstructure effects.*

This implies that there is a trade-off in the choice of h*: a too large a time step may result in a move away from convergence conditions, while a too small a time step may lead to samples highly contaminated by microstructure noise.*

Studies about the impact of microstructure effects on realised volatility were almost all published in the 2000s, notably Bandi and Russell (2003), Aït-Sahalia, Mykland and Zhang (2005), and Hansen and Lunde (2006). The most accomplished study was that of Aït-Sahalia, Mykland and Zhang which assumes that volatility is a random, non-constant variable. The estimator proposed by these authors, two scales realised volatility (TSRV), is based on an estimate of the integrated variance at two different time scales:

- the initial sample is partitioned into *K* non-overlapping subgrids and an integrated variance estimator is calculated for each partition; the average of the estimated integrated variances is then calculated;

- lastly the TSRV[6] is estimated.

Aït-Sahalia, Mykland and Zhang proposed the optimal number of subgrids to be used and showed that their estimator had most of the traditional proprieties of a good estimator (asymptotic convergence, etc.). For simplicity, we can say that TSRV dominates the variance or realised volatility that is biased, as we have already mentioned. Note that in both cases (TSRV or realised volatility), it is possible to isolate the biases from the discreteness and those introduced

6 *More specifically, the final estimator is a combination of the realised volatility calculated during the first stage and that obtained from all the observations of the sample.*

by pure microstructure effects. Furthermore, in a paper yet to be published, Zhang proposed a generalisation of TSRV, the realised volatility at a number of scales (multi-time scale realised volatility, MTSRV) that combines the realised volatilities at more than two frequencies.

Even though recent studies have made real advances in this field, a number of grey areas remain: the estimation methods used continue to pose a problem because the properties of the estimators are not entirely satisfactory; the same is true of the predictive powers of the different approaches put forward. This explains the ongoing interest in this area of research.

2|2 Contribution of the conference

Realised volatility estimators are used as a backdrop for a number of papers presented at the conference. They are considered from different perspectives in the various papers: as indicators in some, while in others their predictive performance is studied and in yet others their different estimation approaches are compared. In view of the bias or reliability problems of some estimators, we shall only present the papers belonging to the two latter categories.

The article by Aït-Sahalia and Mancini studies the predictive performance, in-sample and out-of-sample, of two integrated variance estimators, realised volatility and TSRV. To do this, the authors used as references the known theoretical models (the Heston model, a jump-diffusion model, a HAR-RV model, the Ornstein-Uhlenbeck model, etc.) and then compared these references to the volatilities associated with the two estimators in their study. In all cases, the TSRV very largely dominates the realised variance estimator. In practical terms, the variance or realised volatility, which is very frequently used, skews the perception of volatility, and could affect portfolio allocation behaviour. Consequently, it could have a detrimental impact on risk management.

Curci and Corsi propose a new measure of integrated variance based on MTSRV and a specific prefiltering of the original variables. This prefiltering process is supposed to better correct for microstructure effects. The authors show, *inter alia*, that the generalisation of TSRV proposed by Zhang may be obtained in a relatively simple manner in the framework of their model. The approach advanced by Curci and Corsi therefore appears to be the most complete available today. Furthermore, these two authors highlight the robustness of their method, in particular that of the filtering process that appears to resist the different forms of dependence in the microstructure noise process. They conclude their study with theoretical simulations and estimates based on data from observations of certain financial asset prices (SP500, government bonds, etc.).

This article, which is highly original in that it opens up promising new avenues of research, was very well received and appraised. It was lauded because it extends the work of Aït-Sahalia, Mykland and Zhang who revolutionised the treatment of integrated variance. The referee's main criticism centred on the consistency of the estimator proposed by Curci and Corsi. Indeed, using a simple model, the referee showed that the integrated variance obtained from their model did not really correspond to that expected. This does not entirely call into question the paper, which marks an important step towards the correction of microstructure effects. However, the properties of the estimator will have to be examined in detail.

3| MICROSTRUCTURE AND THE MONEY MARKET

Many articles have covered the empirical aspects of the microstructure of money markets, and more specifically the modelling of their volatility. In his seminal article of 1996, Hamilton shows that the level and the volatility of the Federal funds rate exhibit empirical regularities that may be associated with the operational monetary policy framework: volatility increases significantly over the last days of the reserve maintenance period. Similar results are found for the euro area. Gaspar, Pérez-Quirós and Sicilia (2001) and Bartolini, Bertola and Prati (2003), among others, confirm the existence of seasonal movements in the level and volatility of the interbank rate linked to the Eurosystem's institutional monetary policy framework. The questions currently raised by literature on this topic are slightly different (Pérez-Quirós *et al.,* 2006)

as some papers presented at the conference show. They fall under the three following categories.

3|1 Are the different segments of the money market integrated?

In their article, Bartolini, Hilton and Prati attempt to determine whether the markets for Federal funds and Eurodollars, the two core components of the dollar money market, are integrated. The Federal funds rate is the rate that US banks charge each other for overnight loans of reserve balances. The Eurodollar rate is the interest rate on dollar-denominated deposits held by banks outside the United States. These two markets are the two main sources of funding for US banks, aside from funds obtained from the Federal Reserve.

There are at least two reasons to consider the degree of integration of these markets:

• first, to corroborate or invalidate the findings of previous studies showing that these markets are segmented. This is surprising given that both these markets have been subject to the same regulatory treatment since 1990. Why then might the behaviour of financial institutions result in unexploited arbitrage opportunities between these two markets?

• Second, this question is key for monetary policy implementation and impulses. The US Federal Reserve mainly targets the Federal funds rate. This choice stems from the idea that this market anchors the whole term structure of US interest rates. However, the Eurodollar market appears to be playing an increasing role as a source of bank funding. Funds obtained through borrowing from foreign banks stood at half those obtained from borrowings from US banks at the start of the 1980s. Today, the former amount to almost twice the latter. Recent trends in these markets raise the following question regarding monetary policy transmission: if these two markets are not sufficiently integrated, should the Fed not redefine its target more broadly to encompass trades executed in both markets?

Bartolini, Hilton and Prati consider their degree of integration of these two markets by analysing the predictive power of the interest rate spread between them. Indeed, if the markets are integrated, the spread between the two rates should be unpredictable based on current information. An Exponential-GARCH process was used to model the interest rate spread. They show that the spread between these two rates is generally small and unpredictable. This result tends to indicate that these two markets are integrated.

3|2 Volatility transmission from overnight rates

The volatility of the very short-term euro area interbank market interest rate (EONIA) is sensitive to the operational framework of the Eurosystem. Notably, volatility increases at the end of the reserve maintenance period. This dependence associated with the institutional framework may be problematic if it is transmitted to longer-term interest rates. Indeed, long-term rates affect investment and consumption decisions and therefore have an impact on aggregate demand. Consequently, it is important to determine whether very short-term volatility is transmitted to the rest of the yield curve.

Two papers presented in this session try to answer this question. They are based on different approaches to modelling volatility:

• Durré and Nardelli construct daily volatility series using a sample of intraday observations. Volatility transmission is studied using a vector autoregression across the different maturities;

• Blanco and Alonso base their rationale on a conditional volatility model. The conditional volatility of the overnight rate is first estimated, and then used as an explanatory variable in the representations of the conditional volatility of longer-term interest rates.

The findings of these two articles suggest that volatility is not transmitted from very short-term to long-term interest rates. More specifically, the volatility of the overnight rate does not appear to influence that of interest rates beyond three months.

3|3 The impact of changes to the Eurosystem's operational framework

Prior to the changes to the operational framework in March 2003, problems of overbidding and underbidding in the ECB's main refinancing operations (MRO) could occur. This was mainly due to the fact that reserve maintenance period, which started on the 24th calendar day of one month and ended on the 23rd calendar day of the subsequent month, was independent of the dates of the Governing Council meetings in which ECB interest rate decisions were taken. Furthermore, in view of the maturity of the main weekly refinancing operations, the last MRO settled in one reserve maintenance period extended into the subsequent reserve maintenance period. Consequently, the bid behaviour adopted at the end of one reserve maintenance period could be affected by expectations of changes in the key ECB interest rates during the subsequent reserve maintenance period. In order to resolve this problem, the Governing Council adopted in March 2003 two measures that came into force in March 2004:

• the timing of the reserve maintenance period was changed to start on the settlement day of the MRO following the Governing Council meeting at which the monthly assessment of the monetary policy stance is pre-scheduled and end on the day prior to the settlement of the MRO of the following month;

• the maturity of the MROs was shortened from two weeks to one week.

These combined measures aimed to contribute towards stabilising the conditions in which credit institutions bid in the Eurosystem's MROs (ECB, 2004). They were expected to result in a decline in average interbank market volatility. However, under the new operational framework, the time frame between the last day of the reserve maintenance period and the settlement of the last MRO is equal to eight days, *i.e.* longer than the average time frame under the previous operational framework. This might therefore result in higher volatility at the end of the reserve maintenance period.

The impact of changes to the operational framework on the volatility of the interbank rate is studied in two papers presented at the conference:

• Durré and Nardelli propose a linear model whose endogenous variable is a realised volatility series, previously calculated using intraday observations. This model includes, among other things, as an explanatory variable, a dummy variable taking the value of one for the last days of the reserve maintenance period. It is estimated before and after 2004. The authors show that the average volatility level is significantly lower under the new operational framework[7] ; however, volatility observed at the end of the reserve maintenance period is higher after 2004, corroborating the concerns mentioned above;

• Cassola and Morana show a break in the level of the volatility of the interbank rate in 2004, but it is only significant on the very short end of the yield curve (one to two weeks).

4| COMOVEMENT, RISK AND FINANCIAL STABILITY

In this last part of this summary, we assess the more empirical contributions relating to European markets. To do this, we examine two papers presented at the conference.

4|1 Volatility and financial stability

This first paper is the study mentioned above by Cassola and Morana, which focuses on analysing volatility in the euro area money market. The authors set out to identify the factors behind the volatility in overnight interest rates in the euro area and to study the transmission

7 *See also the July 2006 issue of the ECB's* Monthly Bulletin.

of volatility shocks along the term structure. Their approach is interesting in that it combines the analysis of a real phenomenon with the use of several types of relevant and sophisticated tools:

• Cassola and Morana introduce a factor model and a simultaneous analysis of the short-run and long-run dynamics;

• they then supplement their analysis of volatility, and in particular its persistence, by estimating a realised volatility series, on the basis of high-frequency data (5 minutes), and a long memory process;

• they propose a decomposition approach that takes account of the properties of the series (permanent, persistent, non-persistent decomposition, etc.), making it possible to better understand the characteristics of the volatility.

Cassola and Morana find a number of interesting results:

• volatility persistence can be explained by two common factors, *i.e.* the way in which persistent volatility shocks are transmitted along the term structure, and excess persistent volatility at the longer end of the yield curve relative to the shortest end;

• there appears to be a forward propagation of persistent volatility shocks. But no evidence was found for a forward transmission of liquidity shocks.

However, as the referee stressed, some points should be clarified: for example, how should we interpret the forward propagation of volatility shocks? The authors do not specify what they mean by the "shorter" or "longer" end of the curve. Their results would have been easier to interpret had they given more detail on this point.

4|2 Volatility regimes and the provision of liquidity

The article by Beltran, Durré and Giot sets out to study the relationship between the level of liquidity[8] and the low and high volatility regimes observed in the Belgian order book markets. A number of empirical studies (Biais *et al.,* 1995, for example) have been conducted on this type of market but few of them examine the impact of volatility or rather the impact of the different volatility regimes on liquidity dynamics.

In order to determine the different volatility regimes, Beltran, Durré and Giot propose using either the traditional estimator of integrated volatility (here realised volatility), or traditional multi-regime models that, assuming that there are two regimes, can identify them exogenously. The authors also apply vector autoregression (VAR) models to liquidity in order to study the joint dynamics of a number of variables of interest (liquidity, volatility, etc.).

The main results are:

• the contemporaneous relationship between liquidity and volatility does not appear to be linked to the predominant volatility regime. However, they find that it is more costly to trade when volatility is high;

• the VAR analysis shows that liquidity dynamics are not dependent on volatility regimes. Therefore, liquidity dynamics are fairly similar in low and high volatility regimes. However, a drop in liquidity subsequent to volatility shocks is larger in the high volatility regime;

• the market studied is more resilient to liquidity or volatility shocks during periods of turmoil.

As we saw in Part 1, it is not necessarily wise to identify volatility regimes using realised volatility as the latter may be a biased estimator of integrated variance. We can also question the robustness of identifying regimes using statistical models. The convergence of the results obtained in the two different approaches could be interpreted as gauge of robustness. Further tests could be carried out to confirm the previous interpretation. As the referee stressed the empirical results are interesting but they are not easy to justify: how come liquidity is insensitive to volatility regimes while it is more costly to trade when volatility is high? Furthermore, it is difficult to ascertain whether the results obtained are specific to the Belgian market. It would therefore be interesting to extend the scope of the study.

8 Ex-post *liquidity measures may be obtained from realised bid-ask spreads, trading volumes, the number of orders, and the average volume per trade.*

The articles discussed in this summary do not cover all the topics dealt with at the conference. Nevertheless, they give an insight into the main conclusions that can be drawn:

• from a methodological point of view, the discussions provided an opportunity to consider recent advances in volatility and risk modelling. Progress has been made since the seminal work of Merton but there are still a number of grey areas. Going forward, an improvement in the integrated variance estimators should make it possible to better identify risks and, perhaps, better control them;

• as regards the use of the microstructure approach in the analysis of the money market, the almost complete absence of academic research, at least with regard to the European market, is regrettable. It leads to a lack of innovation in the analysis of these markets;

• lastly, aside from research on the money market for which monetary policy implications are generally clear, it will be necessary in future to more often consider the economic policy implications in research on market microstructures, in particular with a view to preserving financial stability. The analysis of comovements or transmission of volatility shocks along the yield curve is an excellent example of this.

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