High-frequency trading and regulatory policies. A tale of market stability vs. market resilience

by Sandrine Jacob Leal and Mauro Napoletano

Over the past decades, high-frequency trading (HFT) has sharply increased in US and European markets. HFT represents a major challenge for regulatory authorities, partly because it encompasses a wide array of trading strategies (AFM (2010); SEC, 2010), and partly because of the big uncertainty yet surrounding the net benefits it has for financial markets (Lattemann *and al*. (2012); ESMA (2014); Aguilar, 2015). Furthermore, although HFT has been indicated as one potential cause of extreme events like flash crashes, no consensus has yet emerged about the fundamental causes of these extreme events. Some countries' regulations have already accounted for HFT,[1] but, so far, this has led to divergent approaches across markets and regions.

Overall, the above-mentioned open issues call for a careful design of regulatory policies that could be effective in mitigating the negative effects of HFT and in hindering flash crashes and/or dampening their impact on markets. On these grounds, in a new research paper published in the *Journal of Economic Behavior* and Organization we contribute to the debate about the regulatory responses to flash crashes and to the potential negative externalities of HFT by studying the impact of a set of policy measures in an agent-based model (ABM) where flash crashes emerge endogenously. To this end, we extend the ABM developed in Jacob Leal *et al*. (2016) to allow for endogenous orders' cancellation by high-frequency (HF) traders, and we then use the model as a test-bed for a number

of policy interventions directed towards HFT. This model is particularly well-suited and relevant in this case because, differently from existing works (*e.g.,* Brewer *et al*, 2013), it is able to endogenously generate flash crashes as the result of the interactions between low- and high-frequency traders. Moreover, compared to the existing literature, we consider a broader set of policies, also of various natures. The list includes market design policies (circuit breakers) as well as command-and-control (minimum-resting times) and market-based (cancellation fees, financial transaction tax) measures.

After checking the ability of the model to reproduce the main stylized facts of financial markets, we run extensive Monte-Carlo experiments to test the effectiveness of the above set of policies which have been proposed and implemented both in Europe and in the US to curb HFT and to prevent flash crashes.

Computer simulations show that slowing down high-frequency traders, by preventing them from frequently and rapidly cancelling their orders, with the introduction of either minimum resting times or cancellation fees, has beneficial effects on market volatility and on the occurrence of flash crashes. Also discouraging HFT via the introduction of a financial transaction tax produces similar outcomes (although the magnitude of the effects is smaller). All these policies impose a speed limit on trading and are valid tools to cope with volatility and the occurrence of flash crashes. This finding confirms the conjectures in Haldane (2011) about the need of tackling the "race to zero" of HF traders in order to improve financial stability. At the same time, we find that all these policies imply a longer duration of flash crashes, and thus a slower price recovery to normal levels. Furthermore, the results regarding the implementation of circuit breakers are mixed. On the one hand, the introduction of an ex-ante circuit breaker markedly reduces price volatility and completely removes flash crashes. This is merely explained by the fact that this type of regulatory

design precludes the huge price drop, source of the flash crash. On the other hand, ex-post circuit breakers do not have any particular effect on market volatility, nor on the number of flash crashes. Moreover, they increase the duration of flash crashes.

To sum up, our results indicate the presence of a fundamental trade-off characterizing HFT-targeted policies, namely one between market stability and market resilience. Policies that improve market stability – in terms of lower volatility and incidence of flash crashes – also imply a deterioration of market resilience – in terms of lower ability of the market price to quickly recover after a crash. This trade-off is explained by the dual role that HFT plays in the flash crash dynamics of our model. On the one hand, HFT is the source of flash crashes by occasionally creating large bid-ask spreads and concentrating orders on the sell side of the book. On the other hand, HFT plays a positive role in the recovery from the crash by contributing to quickly restore liquidity.

[1] Some unprecedented actions and investigations by local regulators were widely reported in the press (Le Figaro, 2011; Les Echos, 2011; 2014; Le Monde, 2013; Le Point, 2015).

Rock around the Clock: an explanation of flash crashes

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On May 6 2010, contemporaneously with the unprecedented price decrease of the E-Mini S&P500[5], many US equity indices, including the Dow Jones Industrial Average, nosedived by more than 5% in few minutes, before recovering much of the loss. During this "flash crash", most asset prices lost any informational role, as over 20,000 trades across more than 300 securities were executed at prices more than 60% away from their values just moments before. Many were executed at prices of a $0.01 or less, or as high as $100,000, before prices of those securities returned to their "pre-crash" levels (CFTC and SEC, 2010). Such a huge mispricing was associated with a sudden evaporation of market liquidity, swelled volatility and a prolonged crisis in market confidence (average daily volumes were down for several months after the crash). Furthermore, extreme asset misalignments could also be a source of systemic crises in light of mark-to-market financial accounting practices, according to which banks' and other financial institutions' assets are evaluated at current market prices.

The flash crash of May, 6 2010 widely reported in the press was not an isolated incident. Similar episodes have been observed since then in many financial markets. Moreover, because of their disruptive consequences on the orderly functioning of markets, flash crashes attracted the attention of regulators, politicians and academic researchers. In the last four years, many conjectures have been advanced to clarify the origins of the phenomenon and to propose regulatory measures able to prevent its emergence and/or to mitigate its effects. Most theories focused on the role of high-frequency trading (HFT). Indeed, as suggested by a SEC

report, high-frequency (HF) traders may have had a fundamental role in fueling the crash by increasingly selling their positions. However, no convincing explanation has emerged yet and the debate on the benefits and costs of HFT, and its role in flash-crash events, is still unsettled. Some studies suggest that HFT can negatively affect market efficiency, exacerbating market volatility, reducing market liquidity and possibly fueling flash crashes. Others suggest that high-frequency traders are "modern" market makers, who provide an almost continuous flow of liquidity, thus reducing transaction costs and fostering price discovery and market efficiency.

The lack of a consensus on the net benefits of HFT is not surprising, as the ultra-fast algorithms adopted by high-frequency traders represent a genuine financial innovation, whose social impacts are difficult to assess given the legion of associated –often unintended– externalities and the underlying complexity of financial markets. In such a context, agent-based models (ABMs) may represent a powerful tool to study the impact of financial innovations such as HFT on market dynamics. Indeed, ABMs allow the researcher to build artificial markets where price fluctuations can emerge from direct interactions occurring among heterogenous traders, endowed with a repertoire of different trading strategies, ranging from simple to very sophisticated ones (as those employed by HF traders).

Following this intuition, in a OFCE Working Paper n°2014-03, we develop an ABM of a limit-order book (LOB) market, wherein heterogeneous HF traders interact with low-frequency (LF) ones. Our main goal is to study whether HFT is responsible for the emergence of flash crashes and more generally for periods of higher volatility in financial markets. Furthermore, we want to shed some light on which salient features of HFT are relevant in the generation of flash crashes and in the process of price-recovery after a crash.

The model portrays a market wherein LF agents trade a stock,

switching between fundamentalist and chartist strategies according to their profitability. HF agents differ from LF ones not only in terms of speed, but also in terms of activation and trading rules. First, contrary to LF strategies, which are based on *chronological* time, the algorithmic trading required by HFT naturally leads HF agents to adopt trading rules which rest on event time. As a consequence, LF agents, who trade at exogenous and constant frequency, co-evolve with HF agents, whose participation in the market is endogenously triggered by price fluctuations. Second, HF agents adopt *directional* strategies that exploit the price and volume information released in the LOB by LF traders. Finally, HF traders keep their positions open for very short periods of time and they typically display high order cancellation rates. To study the model, we run extensive numerical simulations. Our results show that flash crashes together with high price volatility occur *only* when HF agents are present in the market. Why do flash crashes occur in our model in presence of HF traders? We clearly show that the emergence of flash crashes is not only related to the faster trading speed of HF agents, but more important to the use of specific trading strategies which enable them both to siphon liquidity off the market, leading to high bid-ask spreads[6], and to synchronize on the sell-side of the LOB, when the market crucially needs liquidity.

Finally, we explore the effects of HF agents' order cancellation rate on market dynamics. Order cancellation has received much attention in recent public debates, because HF traders can use it strategically to move prices in the desired directions by filling the LOB with fake orders within few microseconds only to cancel them just as quickly. We find that high rates of order cancellations have an ambiguous effect on price fluctuations. Indeed, a larger rate of order cancellations leads to higher volatility and more frequent flash crashes, but also to faster price recoveries, which in turn reduce the duration of flash crashes. We therefore

suggest that order-cancellation strategies extensively employed by HF traders cast more complex effects than thought so far, and that regulatory policies aimed to curb these practices should take

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[5] A futures contract on the S&P 500 index.

[6] The difference between the highest price a buyer is willing to pay for an asset and the lowest price a seller is willing to sell this same asset.

The financial markets: Sword

of Damocles of the presidential election

By Céline Antonin

Although some of the candidates may deny it, the financial risk linked to the fiscal crisis in the euro zone is the guest of honour at the presidential campaign. As proof that this is a sensitive issue, the launch in mid-April of a new financial product on French debt crystallized concerns. It must be said that this took place in a very particular context: the Greek default showed that the bankruptcy of a euro zone country had become possible. Despite the budgetary firewalls in place since May 2010 (including the European Financial Stability Fund), some of France's neighbours are facing a lack of confidence from the financial markets, which is undermining their ability to meet their commitments and ensure the fiscal sustainability of their government debt, the most worrying example to date being Spain. What tools are available to speculators to attack a country like France, and what should be feared in the aftermath of the presidential election?

The tool used most frequently for speculation on a country's public debt is the Credit Default Swap, or CDS. This contract provides insurance against a credit event, and in particular against a State's default (see the "Technical functioning of CDS" annex for more detail). Only institutional investors, mainly banks, insurance companies and hedge funds, have direct access to the CDS market on sovereign States [1].

Credit default swaps are used not only for coverage, but also as an excellent means of speculation. One criticism made of the CDS is that the buyer of the protection has no obligation to hold any credit exposure to the reference entity, i.e. one can buy CDS without holding the underlying asset ("naked" purchase/sale). In June 2011, the CDS market represented an

outstanding notional amount of 32,400 billion dollars. Given the magnitude of this figure, the European Union finally adopted a Regulation establishing a framework for short-selling: it prohibits in particular the naked CDS on the sovereign debt of European States, but this will take effect only on 1 November 2012.

The FOAT: new instrument for speculation on French debt?

This new financial instrument, introduced by Eurex on April 16 [2], is a futures contract, that is to say an agreement between two parties to buy or sell a specific asset at a future date at a price fixed in advance. The specific asset in this case is the French Treasury OAT bond, with a long residual maturity (between 8.5 and 10.5 years) and a coupon of 6%, and it has a face value of 100,000 euros. Should we worry about the launch of this new contract on the eve of the presidential election? Not when you consider that the launch of the FOAT addresses the gap in yields between German and French bonds that has arisen since the recent deterioration of France's sovereign rating: previously, as German and French bond yields were closely correlated, the FOAT on German bonds allowed coverage of both German and French bond risks. After the gap in yields between the two countries widened, Eurex decided to create a specific futures contract for French bonds. Italy witnessed this same phenomenon: in September 2009, Eurex also launched three futures contracts on Italian government bonds [3]. In addition, Eurex is a private market under German law, and is much more transparent than the OTC market on which CDS are traded. Note that the FOAT launch was not very successful: on the day it was launched, only 2,581 futures contracts were traded on French bonds, against 1,242,000 on German bonds and 13,671 on Italian bonds [4].

Even if, as with the CDS, the primary function of the FOAT is to hedge against risk, it can also become an instrument for speculation, including via short selling. While speculation on French debt was previously limited to large investors, with an

average notional amount of 15 billion euros per CDS [5], the notional amount of the new FOAT contract is 100,000 euros, which will attract more investors into the market for French debt. If speculators bet on a decline in the sustainability of France's public finances, then the price of futures contracts on the OAT bonds will fall, which will amplify market movements and result in higher interest rates on OAT contracts.

The not so rosy future?

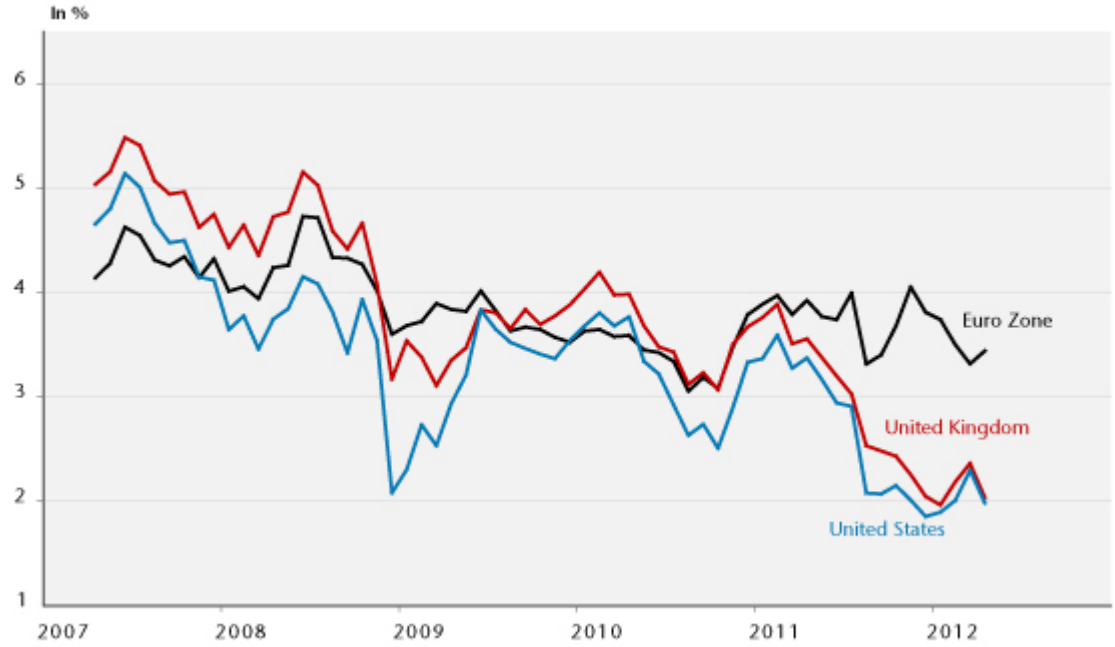
It is difficult to predict how the financial markets will behave in the wake of the French presidential election. Studying what has happened in other euro zone countries is not very informative, due to each one's specific situation. The country most "comparable" to France would undoubtedly be Italy. However, the appointment of Mario Monti in November 2011 took place in an unusual context, where the formation of a technocratic government was specifically intended to restore market confidence through a strenuous effort to reduce the deficit, with Italy also benefitting from the ECB's accommodative policy.

The French budgetary configuration is different, as the financial imperative appears only in the background. The candidates of the two major parties both advocate the need to restore a balanced budget. Their timetables are different (2016 for Nicolas Sarkozy's UMP, 2017 for François Hollande's PS), as are the means for achieving this: for Sarkozy, the focus will be more on restraint in public spending (0.4% growth per year between 2013 and 2016, against 1.1% for the PS), while Hollande emphasizes growth in revenue, with an increase in the tax burden of 1.8% between 2012 and 2017 (against 1% for the UMP).

But this is not the heart of the matter. What is striking, beyond the need to reduce public deficits in the euro zone countries, is the fact that our destinies are inextricably

linked. As is shown by the graph on changes in bond yields in the euro zone (Figure 2), when the euro zone is weakened, all the countries suffer an impact on their risk premium relative to the United States and the United Kingdom, although to varying degrees. It is therefore unrealistic to think about France's budget strategy and growth strategy outside of a European framework. What will prevent the financial markets from speculating on a country's debt is building a Europe that is fiscally strong, has strict rules, and is supported by active monetary policy. This construction is taking place, but it is far from complete: the EFSF does not have sufficient firepower to help countries in difficulty; the growth strategy at the European level agreed at the summit of 2 March 2012 needs to be more comprehensive; and the ECB needs to pursue an active policy, like the Fed, which specifically requires a revision of its statutes. As was pointed out by Standard and Poor's when it announced the downgrade of the French sovereign rating last December, what will be watched closely by the financial markets is the fiscal consistency of the euro zone. On 6 May 2012, what attitude will the next President then take vis-à-vis the construction of the budget and how able will he be to assert his position in the euro zone – this will determine the future attitude of the financial markets, not only vis-à-vis France, but also vis-à-vis every euro zone country.

Figure 1. Average yields on 10-year bonds in the euro zone, the United States and the United Kingdom



Source : Datastream.

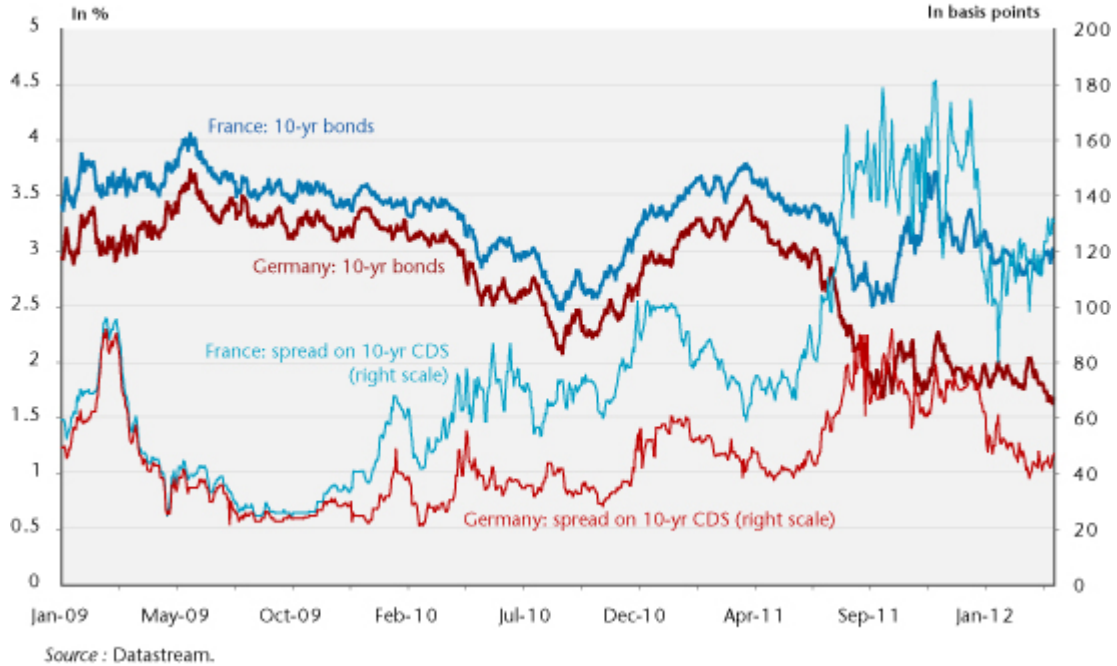
Annex: Technical functioning of Credit Default Swaps

The contract buyer acquires the right to sell a benchmark bond at its face value (called the "principal") in case of a credit event. The buyer of the CDS pays the seller the agreed amounts at regular intervals, until maturity of the CDS or the occurrence of the credit event. The swap is then unwound, either by delivery of the underlying instrument, or in cash. If the contract terms provide for physical settlement, the buyer of the CDS delivers the bonds to the seller in exchange for their nominal value. If the CDS is settled in cash, the CDS seller pays the buyer the difference between the nominal amount of the buyer's bonds and the listed value of the bonds after the credit event (recovery value), in the knowledge that in this case the buyer of the CDS retains its defaulted bonds. In most cases, the recovery value is determined by a formal auction process organized by the ISDA (International Swaps and Derivatives Association). The annual premium that the bank will pay to the insurance company for the right to coverage is called the CDS spread and constitutes the value listed on the market: the higher the risk of default, the more the CDS spread increases (Figure 1). In reality, as the banks are both the buyers and sellers of protection, the spread is usually

presented as a range: a bank can offer a range from 90 to 100 basis points on the risk of a French default. It is thus ready to buy protection against the risk of default by paying 90 basis points on the principal but it demands 100 to provide that protection.

To illustrate this, consider the following example. On 7 May 2012, a bank (buyer) signs a CDS on a principal of 10 million euros for five years with an insurance company (seller). The bank agrees to pay 90 basis points (spread) to protect against a default by the French State. If France does not default, the bank will receive nothing at maturity, but will pay 90,000 euros annually every 7 May for the years 2012-2017. Suppose that the credit event occurs on 1 October 2015. If the contract specifies delivery of the underlying asset, the buyer has the right to deliver its French bonds with a par value of 10 million euros and in exchange will receive 10 million euros in cash. If a cash settlement is expected, and if the French bonds are now listed only at 40 euros, then the insurance company will pay the bank 10 million minus 4 million = 6 million euros.

Annex Figure. France/Germany: premiums on 10-year CDS and 10-year bond yields



Source : Datastream.

[1] Individuals can play on the markets for corporate CDS via trackers (collective investment in transferable securities that replicates the performance of a market index).

[2] The Eurex was created in 1997 by the merger of the German futures market, Deutsche Termin-Borse (DTB), and the futures market in Zurich, the Swiss Options and Financial Futures Exchange (SOFFEX), to compete with the LIFFE. It belongs to Deutsche Börse and dominates the market for long-term financial futures.

[3] In September 2009 for bonds with long residual maturities (8.5 to 11 years), October 2010 for bonds with short residual maturities (2 to 3.25 years) and July 2011 for bonds with average residual maturities (4.5 to 6 years).

[4] Note that this comparison is biased due to the fact that there are 4 types of futures contracts on German debt, 3 on Italian debt and only 1 on French debt.

[5] Weekly data provided by the DTCC for the week of 9 to 13 April 2012 on CDS on French sovereign debt: the outstanding notional amount came to 1,435 billion dollars, with 6822 contracts traded.

Why the developed countries

should renounce their AAA rating

By Catherine Mathieu and Henri Sterdyniak

By their very nature, states with monetary sovereignty should renounce their AAA rating: indeed, what is the logic behind having the rating agencies rate a state whose default is rendered impossible by its ability to create its own money? To avoid dependence on the rating agencies and put an end to the crisis in Europe, the Member States of the euro zone must recover their monetary sovereignty through the joint, virtually complete guarantee of their public debts.

Since 1945, no developed country has defaulted on its debt. There was no risk on the debt, since the states borrowed in their own currency and could always obtain financing from their central bank. The developed countries enjoyed "monetary sovereignty". This is still the case today for Japan (which enjoys 10-year loans at 1% despite a debt of 210% of GDP), the United States (which borrows at 2% with a debt of 98% of GDP), and the United Kingdom (which borrows at 2.5% with a debt of 86% of GDP).

Banks and insurance companies cannot function if they do not have risk-free assets and if they have to guard against the failure of their own state, which is of course impossible: the amounts involved are enormous, and government securities serve to guarantee banking and insurance activities. The banks and insurance companies could not accumulate enough capital to withstand the bankruptcy of their own country or multiple euro zone countries. As we can see today with the sovereign debt crisis in the euro zone, such a requirement would lead to the general paralysis of the banking system.

It is fundamentally absurd that the rating agencies rate a

state with monetary sovereignty, as if its default were an option worth considering. States with monetary sovereignty should renounce their AAA rating: by their nature, their debt is risk-free because it is guaranteed by the central bank's power to create money.

The euro zone countries have lost their "monetary sovereignty": under the Treaty of the European Union, the European Central Bank has no right to finance Member States, and the States are not bound by joint liability. The financial markets noticed this in mid-2009, and suddenly uncontrollable speculation erupted, targeting the most fragile countries in the zone: first Greece, Portugal, and Ireland, which had the fastest growth before the crisis, but will have to change their growth pattern, and then, like dominos, Italy, Spain, and even Belgium. Today, Belgium has to pay an interest rate of 3.8%, Spain 5.2% and Italy 5.6%, compared with 2.6% in France and just 1.8 % for Germany. Greece, Ireland, and Portugal are now in the situation that the developing countries faced yesteryear: their debts have become risky assets subject to high risk premiums, and they are being brought under the yoke of the IMF.

The workings of the financial markets could completely paralyze fiscal policy. When a country enjoys monetary sovereignty, then in a recession the central bank can lower its maximum interest rate and if necessary commit to keeping it low in the long term; the state increases its deficit, but the low interest rates prevent the debt from snowballing; and it pushes exchange rates lower, which boosts activity. Since the debt is guaranteed by the creation of money, there is no risk of bankruptcy, and thus no reason to have to constantly *reassure* the markets. The central bank, by maintaining long-term rates at low levels in a recession, ensures that fiscal policy is effective. Fiscal policy does not need to worry about the markets. This is still the strategy of the United States today.

In the euro zone, the risk is that in the future a country could no longer increase its deficit for fear that the agencies might downgrade its rating and interest rates would then soar. The countries are therefore condemned to prove their virtue so as to appear as wise as Germany in the eyes of the markets. This renders their fiscal policy impotent, and their economic situation spins out of control (see, for example, *The impossible programme of the candidates for the presidential election*). The public debt becomes a permanent risk factor, since the states are at the mercy of the markets' insatiable appetite. Any economic policy should of course be assessed while taking into account the views of the markets. Yet the markets have no special competence in macroeconomics. They impose austerity policies during a recession and then turn around and complain about the lack of growth – which is exactly what they are doing today with respect to the euro zone in general, and Italy and Greece in particular. They are promoting free market reforms such as cutting social welfare programs or the number of teachers. For countries to retain the ability to regulate their economic activity, the risk of default needs to be zero.

The euro zone must thus choose between dissolution and a reform that would guarantee the public debt of the Member States, which would re-gain their "monetary sovereignty". European public debts should become risk-free assets, compensated at low rates but guaranteed in full (by European solidarity and fundamentally by the ECB). This is the only way to maintain the independence of fiscal policy, which is essential given the disparities in Europe and the loss by each country of its monetary and exchange rate instruments.

The functioning of the euro zone was not thought through at the time of its creation, particularly with respect to the trade-off between "autonomy of fiscal policy / single currency / monetary sovereignty". Joint liability creates a moral hazard problem, as each country can increase its debt without

limit, but a lack of a guarantee leaves the field open to the play of the financial markets, which are constantly on the lookout. The guarantee cannot be limited to countries that meet the automatic rules, which is unwarranted economically and fails to comply with the Stability Pact. It should be automatic and total. To avoid moral hazard, the European Treaty should include a provision for the extreme situation where a country carries out an unsustainable fiscal policy, in which case the new debt of the country would no longer be guaranteed – but this should never come to pass.

Freed of the need to reassure the markets, the euro zone countries could engage in differentiated but coordinated fiscal policies, with their main objective being to ensure a return to a satisfactory level of employment consistent with low inflation.