Monetary Policy and Financial Stability: the ECB case

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Abstract:

A wide literature on the topic of the relationship between monetary policy and asset prices has emerged, covering different currents of thought, but the whole approach is limitative because the systemic financial stability cannot be confined to the evolution of asset prices. Therefore, the most important contribution of this paper is to construct a financial instability index for all the Eurozone countries and to test, based on an augmented Taylor rule, if the ECB makes its monetary policy decisions looking at the financial instability signals.
Based on a data sample for the Euro area, we show that the financial instability has a negative influence on the set up of the ECB key rate. More precisely, 20% of the key rate variations find their explanations in the consideration of the financial environment, confirming thus the idea according to which considerable attention is paid by the ECB to the financial instability in its monetary policy decision making process.

Key words: financial stability, monetary policy, asset prices, augmented Taylor's rule

1. Introduction

Recently, a significant part of the scientific community has come to consider as important the role of central banks in achieving financial stability. It is true that not all central banks have played exactly the same roles, reflecting thus their historical backgrounds, as stated by Shirakawa (2010). However, central banking will never be quite the same again after the global financial crisis. As stressed by Borio (2011), no one questions any longer their crucial role in financial stability[1]. In this context, the recent financial crisis has intensified the interest in exploring the interactions between monetary policy and financial stability.

Even if central banks are responsible for the stability of the financial system, they do not always dispose of the necessary instruments to achieve this objective. One offspring of the recent, yet recurring debate on the central banks' role in financial stability assurance is the possibility to use the interest rate instrument in order to prevent financial imbalances construction. Consequently, the preventive role of the monetary policy is questioned and there are no evidences about the results which can be obtained. Nevertheless, during the actual crisis, the leveraging role of the interest rate was brought into full play (BIS, 2011a).

In the last years, an important part of the literature has associated financial instability with a higher volatility in asset prices. Therefore, an important number of studies treated the relationship between monetary policy and asset prices. Perhaps the most striking problem in this case is that the asset prices, especially the stock prices, encounter a very high volatility. A much more important constraint is that, by intervening in reducing their fluctuations, a

[1] There are also authors like Shirakawa (2010) which considers that the financial stability must be the main objective of central banks: "*I think that a primary mandate for a central bank should be to achieve a stable financial environment, that is, a financial environment that is consistent with, and contributes to, sustainable economic growth. Price stability is certainly one important element in achieving a stable financial environment.*"

compromise or trade-off can appear between the objectives of the central banks. Another pain in the neck for those who support the idea of intervention is the incapacity of a precise identification of the bubble.

Despite all these inconveniences, monetary policy can be successfully used for achieving financial stability. Financial stability is not equivalent to a reduced volatility of asset prices. It is about a more complex concept and many studies have tried to define it during the last years. Moreover, several methods were proposed to measure financial stability.

One of these methods is the construction of an aggregate financial stability (or instability) index. The method enables the elimination of the inconveniences associated with the relationship financial stability – asset prices, highlighted by the literature. By looking at the same time at the consumer price index and financial instability index, central banks can reach their objectives.

We then propose to introduce the financial instability index (also called financial stress index) into an augmented Taylor rule. We want to test if the financial instability signals lay behind the decisions made by the ECB, especially in the latest period. In other words, the paper empirically investigates, based on the ECB case, the inclusion of the financial stability into the augmented Taylor's rule.

There are in literature several attempts to include variables which characterise financial instability into an augmented Taylor's rule. However, it is important to consider a complex index to assess financial instability. Moreover, none of those studies focuses on the Euro area case where the problem is more difficult because the ECB must take into account the financial instability signals which manifest themselves in all the Eurozone countries. Therefore, the most important contribution of the paper is the construction of a financial instability index for all the Eurozone countries. At the same time the present study tests, based on an augmented Taylor rule, if the ECB makes its monetary policy decisions considering the financial instability signals.

The remainder of the paper has the following architecture: section 2 presents some evidences about the relationship between monetary policy and financial stability, with accent on the post-crisis mandate of central banks; section 3 describes the construction of the aggregate instability index; section 4 presents the role of monetary policy in achieving financial stability, based on the augmented Taylor's rule; section 5 tests, using an augmented Taylor rule, if the ECB makes its monetary policy decision taking into account the financial instability signals. The last section presents the conclusions.

2. Evidence on Monetary Policy and Financial Stability

The financial stability is traditionally considered as the objective of macroprudential policy, while the price stability is viewed as the objective of the monetary policy[2]. Therefore, a key challenge for central banks is to simultaneously maintain monetary and financial stability (Granville and Mallick, 2009).

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[2] As Galati and Moessner (2011) state, over the past two decades and until the crisis erupted, the literature on monetary policy has seen a broad convergence of views on the policy objective. The literature on macroprudential policy is still far from such a consensus on its objectives. Broadly speaking, macroprudential policy is seen as aiming at financial stability, but there is no commonly shared definition of financial stability.

The macroprudential policy is associated with the regulation and supervision of the financial system, or with the systemic assessment of the financial institutions' stability. It means that the authorities must make some preventive decisions in order to achieve the stability. At present, the policy debate is focusing in particular on the macroprudential tools, as well as on their usage, their relationship with monetary policy, their implementation and their effectiveness.

Monetary policy and macroprudential policy seem to be at the same cross-road. There is an emerging consensus that monetary and macroprudential policies should complement each other (Schoenmaker and Wierts, 2011). At present, central banks have a mandate for price stability as well as for financial stability.

As De Gregorio (2010) states, financial stability was for a long time rather ignored and now it has become the main actor in monetary policy. For example, a study made by the Central Bank Governance Group shows that none of the considered central banks had a clearly articulated financial stability objective that was an explicit part of its formal monetary policy objective. But, according to the same study, a reconsideration of the mandates of central banks in the area of financial stability is necessary (BIS, 2011b). In the authors' opinion, there are three key reasons for which central banks should have a prominent role in financial stability policy: financial instability can negatively affect the macroeconomic environment, central banks are the ultimate source of liquidity for the economy, the performance of their monetary policy functions provides central banks with a macroeconomic focus and an understanding of financial markets needed for the exercise of a macroprudential function.

But the implication of the monetary policy in financial stability objective was not commonly accepted by the academic community and practicing people. Here comes to mind the old and well-known Tinbergen principle which says that we must have at least as many instruments as objectives. This triggered an intense debate which lasted for almost two decades and which discussed the role that the monetary policy could play in assuring financial stability.

This debate, as Brousseau and Detken (2001) show, has divided the financial economists in two categories. A commonly held view argues that the financial system is inherently fragile and that a central bank has occasionally to compromise its objective of price stability when financial stability is threatened (Kent and Debelle, 1998). The opposite view (the "Schwartz-hypothesis") claims that by always pursuing the goal of price stability central banks will in fact best promote financial stability (Schwartz, 1995). Practically, these studies gave birth to two directions, developed by Bernanke and Gertler (2001), respectively by Cechetti et al. (2002). An important number of papers have emerged afterwards, continuing the same line as these predecessors. They all analyse the connection between monetary policy and asset prices.

These two schools of thought approach the issue of whether the central bank should try to influence asset prices. The first one, which is well represented by the present and former Chairmen of the US Federal Reserve, argues that central banks should not use the interest rate to influence asset prices. Recent studies supporting this position were published by García Herrero and del Río (2003) and they show that the focus of the central bank's objectives on price stability reduces the likelihood of a banking crisis. In the same line, Driffill et al. (2006) claim that the interest rate smoothing may be both unnecessary and undesirable and may lead to the indeterminacy of the economy's rational expectations equilibrium. Corbo (2010) shows in his turn that the monetary policy rate is a blunt instrument that is not well-suited to resolve distortions in the financial system.

The second school of thought takes the view that asset prices are often subject to bubbles and crashes. These can have strong pro-cyclical effects and can also affect the stability of financial markets. Since central banks are responsible for financial stability, they should monitor asset prices and try to prevent the emergence of bubbles (that invariably lead to crashes). In this view, the use of the interest rate is seen as effective in preventing bubbles from emerging. Recent studies here are those of Brousseau and Detken (2001), who find that optimal monetary policy should explicitly react to fears of financial instability, or of Pepin's (2010), who shows, using an empirical analysis, that the ECB significantly reacts to financial asset prices by increasing or by reducing its key rate when the stock prices are overvalued or undervalued.

The entire debate focuses however on asset price volatility, but as we will further on show, financial stability is more than that. As a result, the famous remark made by Greenspan (see De Grauwe et al., 2008), namely that the central bank should not "interfere with the pollinating bees of Wall Street" appears as less inspired in this light.

In addition, discussions are held about the trade-off between the two objectives presenting it rather as a conflict between the stability objective and the price stability objective. However, this proves not to be a conflict, rather a trade-off, as shown by Brousseau and Detken (2001). A trade-off between the two objectives exists when changing relative weights in the utility function will lead to an optimal policy, which eventually achieves more of one and less of the other objective, while a conflict would highlight the incompatibility between them. In other words, the present financial crisis put forward the need to give up, on the short run, to one objective in favour of the other, but the direct inflation targeting strategies adopted by most of the central banks in the last period could be an impediment in respect of the involvement of the monetary policy in the assurance of the stability.

The contradiction between the two schools of thought emerges from the debate focused on the asset price volatility. On the one hand, the need to involve the monetary policy in the correction of financial disequilibrium is emphasized and, on the other hand, the incapacity to detect speculative bubbles, thus the inefficiency of the monetary policy, is invoked, besides the risk to which the central bank exposes itself to and the possible failure of the price stability objective.

Indeed, one of the measures used for studying financial instability is asset prices behaviour. Yet, this approach is limitative. First, the central bank has to prevent the occurrence of any type of financial crisis, not only of those generated by asset price bubbles. Second, within many economies, the interest rate smoothing could be inefficient in the attempt to correct asset price imbalances. Third, the tools used for financial and real assets prices might differ. Finally, but not the last, financial asset prices represent a serious problem only for the economies with an extremely developed capital market. Or, the identification of a general method to measure instability must not resume in all situations to asset prices.

As a consequence, monetary policy has to focus on systemic financial stability, namely on the stability of each financial sector: banks, insurances and capital market, as well as on the interdependencies between them. In this spirit, the analysis must cover a wider range of indicators, including those belonging to real economy which could provide an overall image on the financial sector stability.

It is also true that views have changed in the recent period, like Borio (2011) shows. In the pre-crisis period, the dominant view was that the price stability is sufficient for macroeconomic stability, that there is a neat separation between monetary and financial stability functions and that a short-term interest rate is sufficient to capture the impact of monetary policy on the economy. The post-crisis reality states that low and stable inflation does not guarantee financial and macroeconomic stability, that the interest rate policy is not enough, that the regulation and supervision of financial institutions needs to go beyond a microprudential perspective and to adopt a macroprudential orientation, with the central banks playing a key role.

Yes, indeed, the monetary policy can not by itself guarantee the financial stability by means of the interest rate policy, but it can contribute to it. Consequently, the central banks must react to financial stress, leaving aside the mechanical approach to cope with this problem. The time-varying models can be a solution in this case.

3. Aggregate financial instability index versus asset prices

3.1. The advantages of an aggregate instability index

The advantage of such an index, called stability or stress index depending on its construction method, resides in the fact that it represents a more complex analysis of the stability level, approached in its dynamics. To put the sign of equivalence between asset prices and financial stability is limitative. The construction of an aggregate financial instability index (AFII) is more appropriate due to the fact that it limits the volatility of the indicators' value based on which the central banks make their monthly decisions.

The use of a composite index has several benefits (Baxa et al., 2011). First, it approximates the evolution of the financial stress caused by different factors and thus it is not limited to one specific type of instability. Second, the inclusion of additional variables into the instability or stress index does not affect the evolution of the indicator. Third, the composition of the indicator allows breaking down the reactions of the central bank with respect to different stress sub-components.

Such an index can be constructed in different ways and was employed by different researchers, as for example Illing and Liu (2003), Nelson and Perli (2005), Gersl and Hermanek (2006), Rouabah (2007) and Albulescu (2010).

Most of the existing stress indices are based on high-frequency data, but they differ in the selected variables (bank capitalization, credit ratings, credit growth, interest rate spreads or volatility of different asset classes), the country coverage and the aggregation method. An important advantage of continuous stress indicators is that they may reveal periods of small-scale stress that did not result in full-blown crisis and were neglected in studies based on binary crisis variables. Illing and Liu (2003) and Nelson and Perli (2005) describe such an index. More recently, the International Monetary Fund (IMF) published financial stress indices for various countries. Cardarelli et al. (2009) propose, in the same spirit, a comprehensive index based on high-frequency data where the price changes are measured with respect to its previous levels or trend value.

Another method consists in the construction of an AFII by calculating the default rate for the entire financial system, using the Merton approach (Van den End and Tabbae, 2005). A similar index assessing the systemic risk, based on the stochastic distribution of individual financial institutions default, was also proposed by Cihák (2007). The advantage of this method is the interconnection between financial perturbations and business cycle. However, the application of this method supposes liquid capital markets with active banks, which represents an inconvenient for the stability analysis of a less developed financial system.

A more complex method consists in combining market data, balance sheet data and real economy data. Gersl and Hemanek (2006) and Rouabah (2007) have used such a technique. We are the partisans of this technique because it does not put an accent only on market data (data with a high frequency and volatility, which can not be handled by the interest rate decisions made by central banks) and it takes into account other factors which can destabilise the financial sector. In this case also, we can make a distinction between several possibilities. One possibility is to construct sub-indices for each financial sector (banks, financial markets and insurances), like Hollo et al. (2010) and ECB (2010), who constructed a composite indicator of systemic stress (CISS). Another possibility is to construct sub-indices which characterise the development, the external vulnerability and the soundness of the banking systems. However, the last method is more appropriate for the transition countries (see Albulescu, 2010, 2011).

In this section, which is meant to construct an aggregate or composite financial instability index for the Euro area countries, we have chosen to work with 19 indicators which characterise the financial instability and which can be grouped in four distinct categories: financial markets' instability, banks' financial soundness, external financial vulnerability and internal financial vulnerability. However, we do not calculate a composite index for each category, but we have assigned the same importance to the 19 individual indicators into the aggregate index.

No matter the technique employed, there are a few steps in the aggregate financial instability index construction. After the indicators are defined, they have to be quantified. The accuracy level and the measurement scale have to be established. It often happens that the individual indicators do not have the same accuracy or the same units of measurement, situation which is obviously complicating the aggregation into a synthetic index. The indicators' values have thus to be normalised (different normalisation methods can be used).

The next step in index construction is the aggregation of individual values. This equals with an answer to the following questions: Do all criteria have to have the same weight or different weight are needed, and if so, which are these different weights? Which is the relation between the aggregate index and the individual indicators? A sum or an arithmetic average has to be calculated?

Even if the normalization and the aggregation methods raise important theoretical and practical problems, the major inconvenient relates to the indicators weighting. We can choose either to give the same importance to all the variables or to apply a different weight based on the decision making criteria. The standard procedure consists in giving the same weight to all the variables included in the aggregate index. Another possibility is to transform the variables in percentiles, using their sample cumulative distribution function – CDFs (Rouabah, 2007).

3.2. The construction of an aggregate instability index for the Euro area

The 19 financial instability indicators, employed in different research papers on this subject, are presented in Table 1.

Table 1. Financial instability indicators

Individual indicators	**Expected contribution to the financial instability**	**Database**
Financial market instability indicators		
Volatility of the stock index return	+	Yahoo finance and National stock exchange
Stock market capitalization (% GDP)	-	Eurostat
Interest rate spread: Government bond and 3-month Euribor rate	+	Eurostat and ECB
Banks financial soundness indicators		
Bank nonperforming loans to total loans	+	OECD and IMF
Bank capital to assets ratio	-	OECD and IMF
Bank regulatory capital to risk-weighted assets	-	OECD and IMF
ROA	-	OECD and IMF
ROE	-	OECD and IMF
Liquid assets to total assets	-	OECD and IMF
Regulatory Tier 1 capital to risk-weighted assets	-	OECD and IMF
External financial vulnerability indicators		
REER[3] excessive depreciation or appreciation	+	Eurostat
International reserves to imports ratio	-	Eurostat
Current account deficit to GDP	+	OECD and Eurostat
Economic sentiment indicator	-	European Commission
Internal financial vulnerability indicators		
General government deficit to GDP	+	Eurostat
Public debt to GDP	+	Eurostat
Interest rate volatility	+	OECD and Eurostat
Loans (% change)	+	OECD
Credits to deposits ratio	+	OECD

In the first step, we have chosen the individual indicators which are calculated on a quarterly basis[4], for the period 1999:Q1 up to 2011:Q1. The financial instability can be associated either with a high or with a low value, depending on the nature of the indicators. For example, financial instability is linked with a high value of non-performing loans and with a small value of banking profitability (ROA).

For the second step in the index construction, a re-scaling approach was employed to normalise the values of the individual indicators, for each Euro area country.

$$\mathrm{I}_{\mathrm{ijc}}\,\mathrm{n} = \frac{\mathrm{I}_{\mathrm{ijc}} - Min\ (I_i)}{Max\ (I_i) - Min\ (I_i)} \qquad (1)$$

where: I_{ijc} represents the indicator *i* during the period *j* corresponding to the country *c*, $Min(I_i)$ and $Max(I_i)$ represent the best value and, respectively, the worst value registered by the indicator *i* during the analysed period in the respective country and $I_{ijc}n$ is the normalised value of the indicator.

The re-scaling method retains the worst and the best of the values reached by the corresponding indicator for the entire period. The normalised indicators receive values ranging in the interval [0;1].

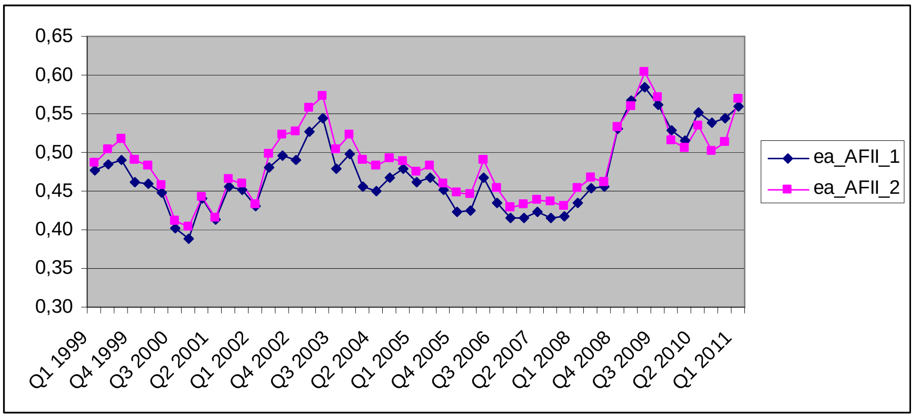
[3] This indicator – deflated real effective exchange rate – is calculated by Eurostat, taking into consideration the 41 most important commercial partners of each country. The REER aims to assess a country's price or cost competitiveness relative to its principal competitors in international markets.
[4] Where the quarterly data are missing (for the most financial soundness indicators), we have employed linear extrapolation to transform annual or biannual data into quarterly data.

In the third phase, the AFII for each country is calculated as an arithmetic mean of the data available for the 19 normalised individual indicators (the standard procedure[5]):

$$AFII = \frac{\sum_{i=1}^{19} I_{ij}}{19} \qquad (2)$$

In our case there is a fourth phase also, that is the calculation of the AFII for the entire Euro area. A simple method is to compute the AFII average for each Eurozone country (ea_AFII_1). But we can say that some countries, like Germany or France, are bigger and have more important financial systems. Therefore, special attention can be paid to these financial systems. In these conditions, the AFII for the Euro area can be constructed by weighting the countries' AFII with their percentage into the Euro area GDP (ea_AFII_2)[6]. However, as Figure 1 shows, there is not a significant difference between these two methods.

Fig 1. Euro area aggregate financial instability index



We can make several observations looking at Figure 1. First of all, we can observe that the financial instability in the Euro area has increased after the bust out of the international financial crisis and not before. For example, in 2001 and 2007, the AFII showed low values which increased after a year, in fin 2002 – beginning of the 2003 and fin 2008 – beginning of 2009 respectively. The highest instability value is recorded in the second quarter of 2009. Second, we can observe that the degradation of the financial systems' conditions occurs after the international financial stress events. This means that the financial systems of the Euro area are not per se an instability source, but they are affected by the globalisation process.

Further information on this subject can be obtained by analysing Annex 1, where the AFII for each country are presented. The convergence of the AFII is important. In general, the instability level increased in the analysed period. In addition, there are several countries like Greece,

[5] We have selected this simple weighting technique because it is difficult to justify the assignment of different weights to the individual indicators. At the same time, the most rigorous, principal components analyses can be criticised due to the fact that some indicators with high volatility during certain crisis periods show a different behaviour in different instability episodes. However, selecting the individual indicators and determining the weights based on the PCA method could represent an alternative which may be subject to future research.

[6] In all the cases, the AFII for the Euro area is calculated only based on the AFII of each country member of the Eurozone at that moment. The Estonian AFII was included into the Euro area AFII only for the first quarter of 2011.

Spain, Portugal, Slovenia or the Slovak Republic which passed through a deterioration of the financial system stability in the last years[7].

4. Financial instability and monetary policy rules

The reaction of the interest rate policy to financial instability was usually investigated in the framework of a monetary policy rule. In most of the cases, the asset prices volatility was associated with the financial instability.

Monetary policy rules can be classified into targeting rules and instrument rules. On the one hand, targeting rules are designed by solving a central bank's optimizing program that defines an objective (loss) function and considers a single model describing the economy. Targeting rules are thus model dependent. Typical policy targets in the central bank objective function are the variability of inflation, the output gap, or the nominal interest rate.

On the other hand, the simple rules can easily be implemented by the central banks. A simple rule is recommended when it provides good stabilizing properties in a variety of models, without any explicit optimality requirement. These simple rules are called instrument rules. A quite popular example of an instrument rule for the nominal interest rate is the well-known Taylor rule. According to this interest-rate rule, the central bank would raise (cut) the nominal interest rate as a combined response to inflation deviations above (below) its target and to positive (negative) observations of the output gap. Advocates for instrument rules argue that targeting rules based on optimal control can be misleading due to their strict dependence on the model. In addition, the reaction function implicitly derived from targeting rules becomes "operational" for policy making only within very simple models involving fully observable variables.

The papers which tempt to study the relation between monetary policy and financial stability into an augmented Taylor rule can be classified in two categories: those analysing the Taylor rule as part of a dynamic stochastic general equilibrium model (DSGE)[8] and those testing the reaction of the key interest rate to indicators which characterise financial stability. Only several papers are interested in the ECB case.

In the *first category of studies*, Gray et al. (2007) propose a simple four-module monetary policy model which consists of an equation for the GDP output gap, an equation for the inflation, an equation for the exchange rate and real interest rate, and a Taylor's rule for setting the domestic policy rate. The inclusion of financial system risk indicators and of other financial risk parameters into simple monetary policy models is explored. The authors employ a contingent claim framework.

Bauducco et al. (2008) contribute to the analysis of monetary policy in face of financial instability. In particular, they extend the standard new Keynesian dynamic stochastic general equilibrium model with sticky prices to include a financial system. Our simulations suggest that if financial instability affects output and inflation with a lag and if the central bank has

[7] The data for 2011:Q1 must be carefully analysed because only a part of the indicators are available for each country and the results can be easily misinterpreted.
[8] DSGEs gained popularity among academics and central banks, as tools for policy discussion and analysis, because of their usefulness in identifying sources of economic fluctuations, and for forecasting and predicting the effects of policy interventions (Goodhart et al., 2009).

privileged information about credit risk, monetary policy that responds instantly to increased credit risk can trade off more output and inflation instability today for a faster return to the trend than a policy that follows the simple Taylor's rule with only the contemporaneous output gap and inflation. In the model, the central bank responds to financial sector instability not because the financial sector developments would have a direct place in its utility function, but simply because responding this way improves developments in future inflation and output.

Cecchetti and Li (2008) estimated an augmented Taylor rule by a measure of banking stress. They have found that a potential conflict between monetary policy and financial supervision can be avoided if the interest rate rule takes (procyclical) capital adequacy requirements into account, in particular if the policy interest rates are lowered when financial stress is high. Christiano et al. (2008) suggested augmenting the Taylor rule with aggregate private credit and has reached the conclusion that such a policy would raise welfare by reducing the magnitude of the output fluctuations.

More recently, Sedghi-Khorasgani (2010) has investigated the effect of financial instability on the design of monetary policy rule for a small open economy, using a DSGE model. In the same spirit, Cúrdia and Woodford (2010) showed the desirability of modifying a standard Taylor rule for a central bank's interest-rate policy to incorporate either an adjustment for changes in interest-rate spreads or a response to variations in the aggregate volume of credit. They have conducted their analysis using the simple DSGE model with credit frictions. Like Teranishi (2009), they have found little support for augmenting a Taylor rule by the credit volume given.

This category also includes papers which are different from the point of view of the employed methodologies. For example, Angelini et al. (2011) used a dynamic general equilibrium model featuring a banking sector to assess the interaction between macroprudential policy and monetary policy. They have found that, in "normal" times, macroprudential policy generates only modest benefits for macroeconomic stability over a "monetary-policy-only" world. All in all, their results suggest that the benefits of macroprudential policy crucially depend on the source and magnitude of the shocks and on the degree of coordination with the monetary policy.

For testing the relation between monetary policy and the state of the economy, Valente (2003) resorted to a vector autoregressive model. The short interest rate was set taking into account the current and future states of the economy. His research was based on a nonlinear estimation of monetary policy reaction function. The last study that we mention in this category is that of Vu (2010). The paper investigated the conduct of monetary policy and financial stability when there are costly financial intermediaries in a standard real business cycle menu-cost model. This paper showed that the behaviour of monetary policy should pay attention to the stability in the financial market, while still keeping an eye on other horizons, including inflation and output.

In *the second category of studies*, financial stability is traditionally associated with asset prices. For example, Casares (2007) scrutinized the stabilizing properties of alternative monetary policy rules in the ECB case. His finding was that a simple rule that provides the reaction of the nominal interest rate to price inflation, wage inflation, and its previous observations, can fairly well approximate the optimal monetary policy. The author also made a description of monetary policy rules.

Levieuge (2005), analysing the wide literature on monetary rules, focused in particular on the papers trying to establish if it is optimal for central banks to assign the same importance to the asset price as they assign to the other two targets, that is the inflation and the output gap. He concluded that mechanically answering to asset prices' movements may lead to an inappropriate strategy.

Granville and Mallick (2009) tested if low and stable inflation has been associated with financial stability characterized in terms of changes in share prices, interest rates and nominal effective exchange rate. First, they had established whether there is a direct link between inflation and asset prices by estimating the response of the term structure of interest rates, share prices, nominal effective exchange rate, house price inflation and bank deposit–loan ratio (proxies for financial stability) to changes in the price level (proxy for monetary stability). Second, they investigated whether and to what extent changes in asset prices have been caused by inflation shocks and – extending this analysis – policy responses through the ECB policy rate

Others articles employ different variables in order to consider the financial stability aspects, and one of the most important variables is the credit development. Bulír and Cihák (2008) estimate the monetary policy response to seven alternative measures of financial sector vulnerability (crisis probability, time to crisis, distance to default or credit default swap spreads) in a panel of 28 countries. The dependent variable was the interest rate closely related to the official (censored) policy rate.

Belke and Klose (2010) assessed the differences that emerged in the estimations of the Taylor's rule for the FED and the ECB, before and after the outburst of the subprime crisis. For this purpose, they applied an explicit estimate of the equilibrium real interest rate and of potential output in order to account for variations within these variables over time. They argued that measures of money and credit growth, interest rate spreads and asset price inflation should be added to the classical Taylor's rule because these variables are proxies of a change in the equilibrium interest rate and are, thus, also likely to have played a major role in setting the policy rates during the crisis. Hence, they estimated the Taylor reaction functions for both central banks, separately for the period before the start of the financial turmoil and the period thereafter, in order to test whether there were significant differences in the response coefficients in both periods.

A recent study which is in line with our research is that of Baxa et al. (2011). They investigated whether and how the main central banks responded to episodes of financial stress over the last three decades. They employed a new methodology for the estimation of the monetary policy rules, which allows for time-varying response coefficients, correcting at the same time endogeneity. Their findings suggest that central banks often change policy rates, mainly decreasing it in face of high financial stress.

5. The augmented Taylor's rule: application for the Euro Area

In this section we introduce the financial instability index into the Taylor rule (the augmented Taylor rule) to see to what extent it can improve the explanation of the monetary policy rule. Based on a data sample for the Euro area, we show that the financial instability has an important influence on the set up of the ECB key rate.

5.1. The standard Taylor rule

The starting point for the empirical analysis is the standard Taylor rule:

$$r_t = \bar{r} + \alpha \inf l_t + \beta x_t + \varepsilon_t \quad (3)$$

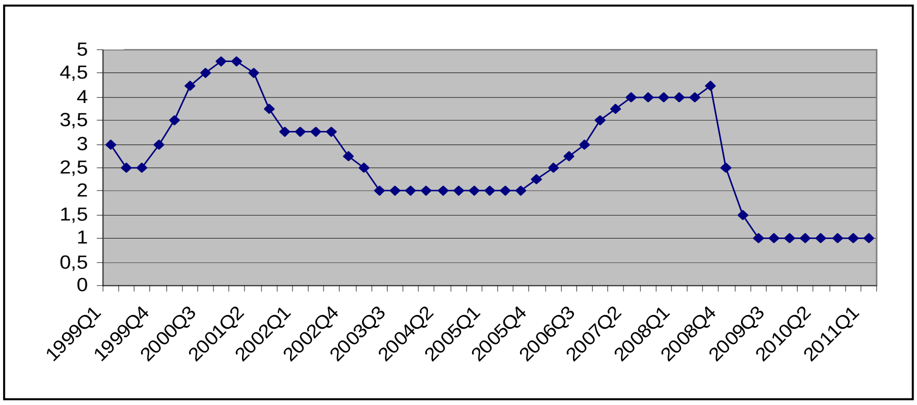
where: ε_t represents an error term included so as to consider the variations of the interest rate r_t (key rate) which are not explained by the model.

We have used quarterly data (more exactly, end of quarter values were available). The observation period covers the first quarter of 1999 up to and including the first quarter of 2011. The interest rate retained into the analysis is the main refinancing rate observed at the end of each quarter.

The variable $infl_t$ refers to the yearly inflation rate of the Eurozone and it is the deviation from the 2% target. x_t is the yearly GDP growth rate. x_t is centred, that means it is taken into account as a deviation from the long term growth rate. This choice is explained by the fact that, in practice, the central banks work in real time, using observable data, namely the growth rates[9]. The constant $\bar{r}$ represents the value of the long term interest rate (when the inflation is equal to its target value and when the growth rate is equal to its average value).

We have to mention that, by construction, the end-of-period macroeconomic data are observable when the central bank has to make its decision related to the key rate. This means that the central banker observes $infl_t$ and x_t to determine r_t. In this case, there are no endogeneity problems. The key rate can influence the future values of $infl_t$ and x_t (moreover, this is the objective of the monetary policy), but not the present values which are exogenous.
Figure 2 shows the evolution of the key rate during the period covered by the sample:

Fig. 2. The key rate r



The Taylor rule says that the variations of the key rate observed in Figure 2 have to be explained by the variations of the inflation and growth rates. The existence of linear connections between the key rate and the interest rate, on the one hand, and between the key

[9] The estimation of the output gaps has a considerable degree of uncertainty and it is always subject to significant corrections several quarters after the publication of real time output gap. Some authors have thoroughly shown the danger related to the use of inaccurate macroeconomic data, which can bring the monetary policy to generate procyclical effects rather than countercyclical ones (Orphanides, 2003).

rate and the growth rate, on the other hand, can be confirmed by the analysis of the scatter plots, mapping quantitatively the two categories of data points ($infl_t$, r_t) and (x_t, r_t):

Fig. 3. Inflation rate and key rate

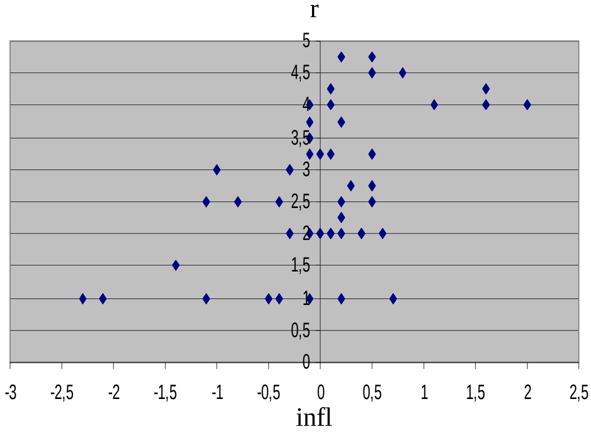
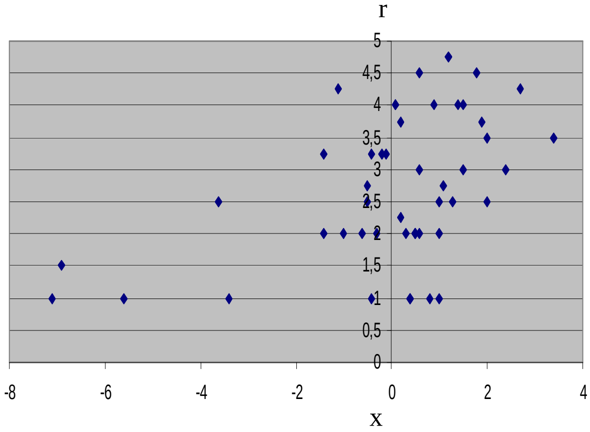


Fig. 4. Growth rate and key rate



These figures suggest the existence of a linear correlation between the key rate and the inflation and the growth rates. The equation 3 is estimated by the ordinary least squares method. The results are brought forward to Table 2.

The estimated parameters have the expected sign and they are all significant. Nevertheless, R^2 shows that only one third of the key rate variations are explained by those of the inflation and the growth rates. The Fisher statistic is however high, the associated critic probability being negligible and showing that the regression is significant at global level.

5.2. The augmented Taylor rule

Growth and inflation are obviously significant determinants of the monetary policy rule, but the weakness of the R^2 in the standard Taylor rule recommend the search and identification of other explanatory variables. This is the reason for which we have added into the model the financial instability index ($afii_t$) defined under the previous section. This indicator must be considered as a risk indicator. When it increases, the risk premium required by investors also knows an augmentation. In order to stabilize the asset prices, the central banker would be then forced to lower its key rate so that the decrease of the risk-free interest rate compensates, at least partially, the increase of the risk premium. In this manner, the central banker would make the financial cycle smoother. As a result, the expected sign for the variable $afii_t$ is negative.

Fig. 5. Aggregate financial instability index

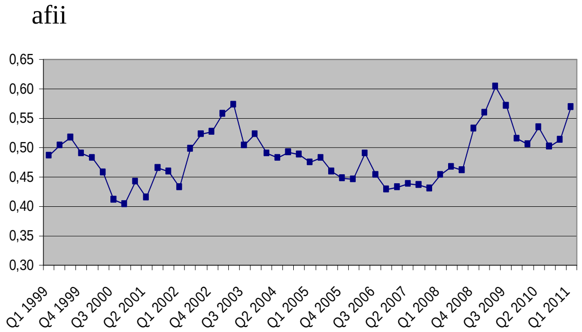
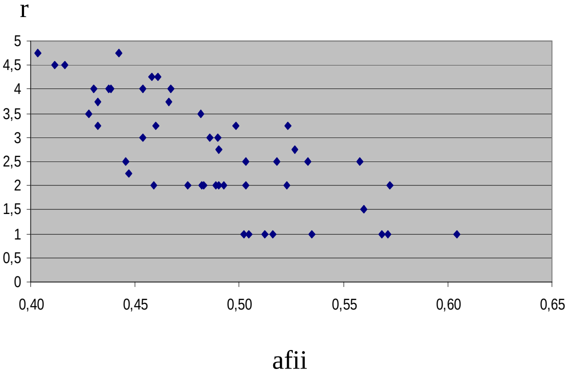


Fig. 6. Instability index and key rate



Nevertheless, the instability index is susceptible of also considerably covering the influence of the inflation rate and mainly that of the growth rate, as suggested by the analysis of the correlation coefficients between the instability index and the other explanatory variables of the monetary policy rule (the coefficient of the linear correlation of $afii_t$ and of $infl_t$ has the value -0.534, and that of $afii_t$ and x_t reach the value -0.621).

In order to approach this kind of problems, it is convenient to reduce the financial instability index to its purely financial component. In this case we have to construct a corrected index, marked with $inst_t$, which measures the residual financial instability, i.e. which is not already contained into the macroeconomic indicators[10]. To achieve this, we perform a regression (using the method of OLS) of the variable $afii_t$ on the macroeconomic indicators and the residues of this regression correspond to the variable $inst_t$[11].

This residue is afterwards inserted in the augmented Taylor rule. We then estimate the new augmented monetary policy rule:

$$r_t = \bar{r} + \alpha\, infl_t + \beta\, x_t + \gamma\, inst_t + \varepsilon_t \qquad (4)$$

The results are shown in Table 2.

Table 2. Estimations of the results

	Equation 3			Equation 4			Equation 5		
	coeff.	t. stat	p. values	coeff.	t-stat	p-values	coeff.	t-stat	p-values
r_{t-1}							0.813	16.81	< 0.0001
$\bar{r}$	2.70	19.74	< 0.0001	2.70	24.70	< 0.0001	0.472	3.42	0.0014
$infl_t$	0.54	2.69	0.0099	0.54	3.37	0.0016	0.065	0.95	0.3450
x_t	0.15	2.01	0.0505	0.15	2.51	0.0156	0.129	5.77	< 0.0001
$inst_t$				- 16.65	-5.19	< 0.0001	- 4.233	-3.04	0.0040
R^2	0.3274			0.5795			0.9451		
F	11.19		0.0001	20.67		< 0.0001	185		< 0.0001

All the estimated parameters have the expected sign and they are without any doubt significant. As compared to the standard monetary policy rule (3), we also observe that the consideration of the financial instability index brings forward a hardly to ignore additional explanation. The relative increase of R^2 shows that 43% of the explanation of the monetary policy rule is due to the financial component. It is thus obvious that the instability index plays a significant role.

Moreover, the orthogonal approach of the financial instability index entails different advantages. First, the constant term $\bar{r}$ regains an interpretation in terms of long term interest rate which it would have lost by the introduction of the variable $afii_t$. In fact, on the long run, the inflation rate is equal to its target, the growth rate is equal to its average value and the orthogonal instability index is equal to its null value. The conclusion is that, on long term, $r_t = \bar{r}$, situation which simplifies the interpretation of the augmented model.

[10] Such an indicator has the advantage of being in accordance with the "judgement" variables invoked by Svensson (2003) to explain the gaps between the interest rate and the forecasts provided by the monetary policy rules.

[11] This regression provides the following results: $afii_t = \underset{(96,59)}{0,486} - \underset{(-2,35)}{0,017}\, infl_t - \underset{(-3,73)}{0,010}\, x_t + \hat{\eta}_t$, $R^2 = 0,45$, $F = 18,92$.

The indicator $inst_t$ represents thus just the error term of this regression: $inst_t = \hat{\eta}_t$

Then, as the indicator is orthogonalized, we can clearly measure the part of the interest rate which is explained by the macroeconomic component and that explained by the financial component. The importance of the financial instability index can be accurately quantified at the regression level. But the presented orthogonalisation also entails the advantage of providing a simple interpretation of the quantity $\gamma inst_t$. At the level of each observation of the rate, we can really measure this quantity which represents the stress of the instability index on the interest rate. For a "normal" level of the instability index, the index is null (long term value), and the instability does not exert any pressure on the key rate. If the instability is considerable, $\gamma inst_t$ takes a negative value which indicates a decreasing pressure on the interest rate, measured directly in basis points. For example, a value of -1 indicates that the consideration of the instability makes the key rate one point lower (as compared to the situation when the instability did not affect the monetary policy, namely if $\gamma = 0$).

Nevertheless, the monetary policy rule estimated this way still remains insufficient to explain a decision which, in theory, presents no error term. The R^2 remains too weak, which is not astonishing having in mind the Figure 2 which shows a strong inertness in the key rate trend. In fact, one time out of two (25 times out of 49 to be more precise), the interest rate at the end of the quarter is equal to the rate of the previous quarter. This strong inertness of the monetary policy rule has caused the economists to add the interest rate lag as explanatory variable. We present further on the estimation results of the model (4) taking into account this inertia.

5.3. The augmented Taylor rule with partial adjustment

We note with r_t^{LT} the long term rate, forecasted based on the standard monetary policy rule (4). Under the assumption of a partial adjustment, the interest rate effectively set up by the central banker is the following:

$$r_t = \rho\, r_{t-1} + (1-\rho)\, r_t^{LT} = \rho\, r_{t-1} + k + a\, infl_t + b\, x_t + c\, inst_t + \eta_t \qquad (5)$$

where: $k = (1-\rho)\,\overline{r}, \quad a = (1-\rho)\,\alpha, \quad b = (1-\rho)\,\beta, \quad c = (1-\rho)\,\gamma \;$ et $\; \eta_t = (1-\rho)\,\varepsilon_t$.

The results of the model 5 estimation are presented in Table 2, above.

The regression is significant, the R^2 having considerably increased. Taking into account the very strong inertia of the key rate, it is not surprising to see the autocorrelation term gaining such an importance in the statistic explanation of its dynamics. All the estimated parameters present the expected sign and they also are very significant, except for the parameter related to the growth[12].

Figure 7 indicates that the forecasts made using the monetary policy rule are of a quite good quality, the forecasts being very close to the estimated values.

Figure 8 presents the prediction errors of the model, following the chronological order of the observations. It is interesting to analyse it, as one should not forget that the linear model is only an approximation of the real, probably non-linear, rule. In fact, the monetary policy rule of the

[12] The strong correlation between growth and inflation raises a more important collinearity problem in a model with partial adjustment than in a model without adjustment. If one orthogonizes the growth rate as compared to the inflation rate to see the "pure" effect of the growth, and if one replaces the original variable with the orthogonal variable in the regression above, then the macroeconomic variables are both significant. The parameter of the inflation reaches thus the value 0.24, the critic probability passing at 0.0003.

ECB presents a minimal variation reaching a quarter of a basis point (¼ *tick*). The forecasting errors below this quarter of a basis point (the most numerous) can thus be considered as errors generated by the approximation of a discreet rule by means of a continuous rule. The only important errors are those exceeding this quarter of a basis point. From this perspective, if we consider that the estimated model stands for the reference rule, the ECB scaled off only during two periods, in 2001, when it did not decrease its key rate rapidly enough, and in 2008, when the most important error occurred, as the ECB increased its key rate whereas the model forecasted a decrease, to which it resorted afterwards. The monetary policy rule anticipated the continuation of the interest rate decrease in 2009, without merely relying on the importance of the rule's inertia.

Fig. 7. Forecasts based on the augmented Taylor rule

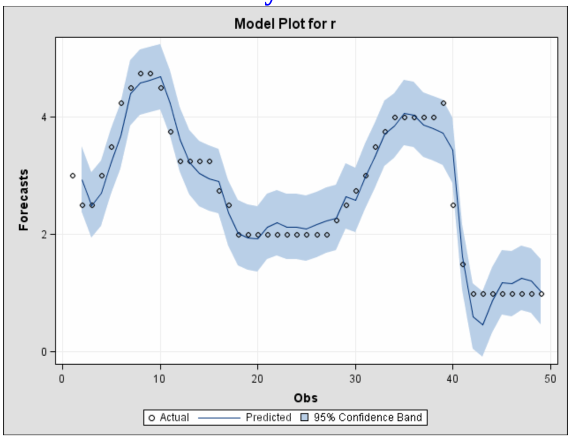
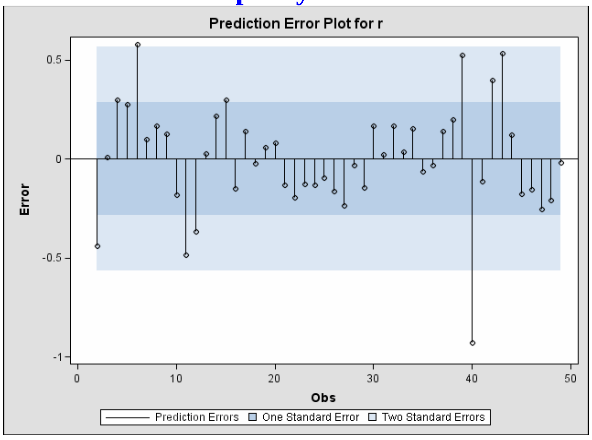


Fig 8. Forecasting errors of the monetary policy rule



In general, the previous estimation results indicate a rule of statistically good quality where the financial instability aggregate indicator plays a significant role. On the short run, the effects of the macroeconomic variables and those of the financial component are weak, the adjustment being only partial. On the long run, the adjustments are complete and they can be estimated based on the long term rule: $r_t^{LT} = \bar{r} + \alpha \inf l_t + \beta x_t + \gamma inst_t + \varepsilon_t$ which can be rebuilt starting from the estimation results of the model. The financial component explains then only 18.54% of the explained variations of the long term rate (with complete adjustment)[13]. The financial component explains 20% of the adjustments as compared to the 80% explained by the macroeconomic component. Referring to the model (4), this may seem little, but these results would be essentially explained by the fact that the instability index is by itself subject to a powerful inertia (Figure 5). If the lagged interest rate is missing, the inertia of the financial instability index explains the inertia of the interest rate, creating the illusion of a strong explanation provided by the financial component. Once the inertia of the monetary policy rule is really taken into account, the explanation connected to the financial instability "deflates" but still remains very important.

Conclusions

This paper analyse if the monetary authorities take into account the financial instability when making their decisions related to the key rate level. This issue is often approached in literature

[13] The share of the variation of $\gamma inst_t$ in $\bar{r} + \alpha \inf l_t + \beta x_t + \gamma inst_t$ has the value 0.1854.

in a limitative manner, as the financial instability is only mirrored by the price volatility of the financial or real assets.
Our research is based on the ECB case. First of all, we construct a financial instability index which covers the Eurozone and synthesizes four sources of instability: financial markets instability, banks financial soundness, external financial vulnerability and internal financial vulnerability. Then, we proceed to the introduction of this index in a standard monetary policy rule.

We afterwards show that the financial instability negatively influences the set up of the key rate, and more exactly, that 20% of the key rate variations are explained by the consideration of the financial environment, confirming thus that the ECB effectively worries for the financial instability and takes it into account in the monetary policy decision making process.

Acknowledgements

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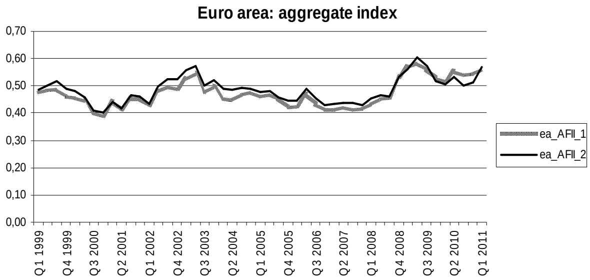
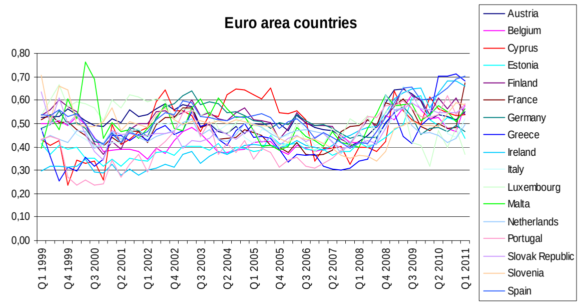
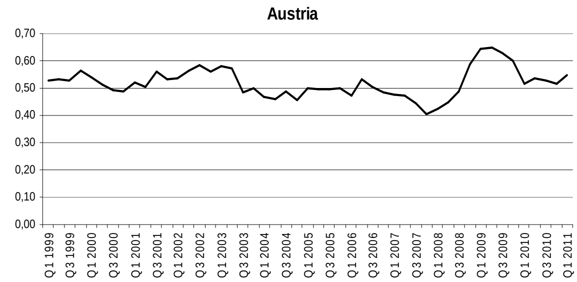
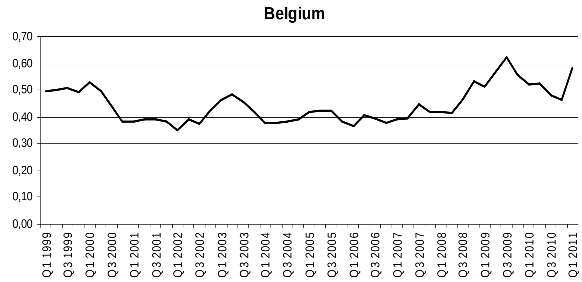
Annexes

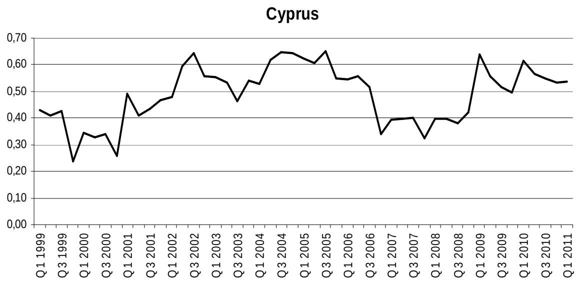
Annex 1: Aggregate financial instability index in Euro area countries

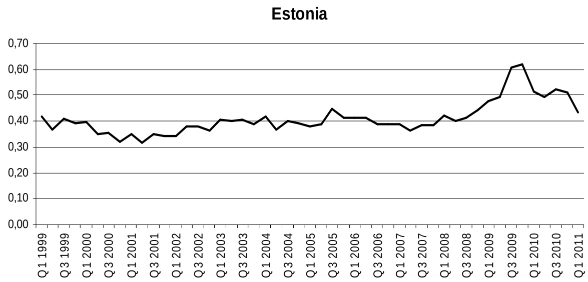


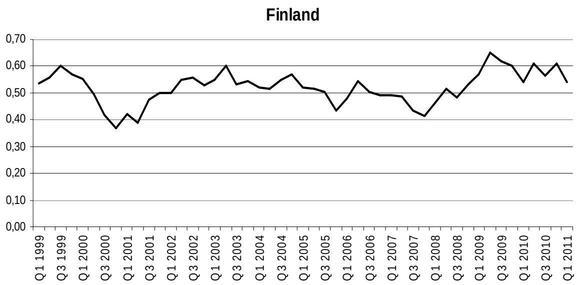


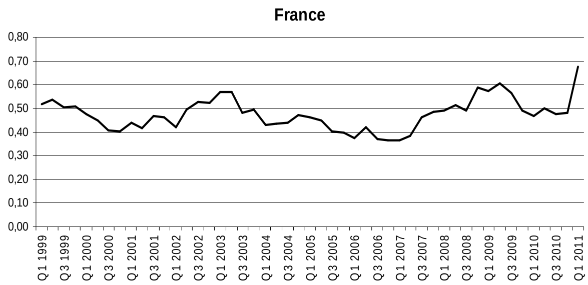


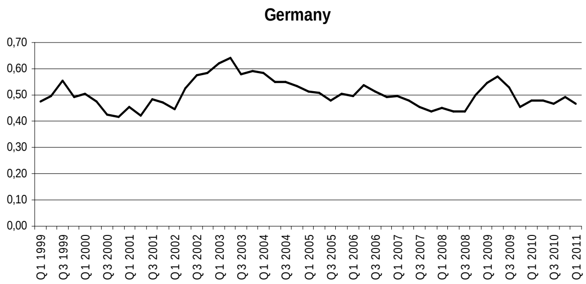


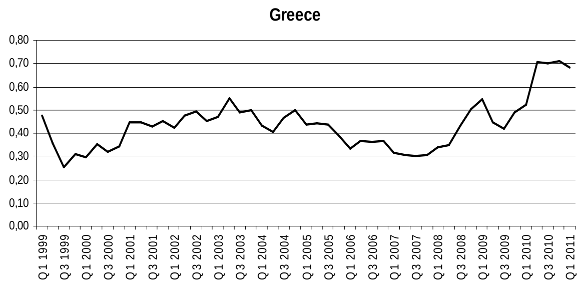












Annex 1: Aggregate financial instability index in Euro area countries – continue