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Assessing the link between price and financial stability☆

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ABSTRACT

This paper aims at investigating first, the (possibly time-varying) empirical relationship between price and financial stability, and second, the effects of some macro and policy variables on this relationship in the United States and the Eurozone. Three empirical methods are used to examine the relevance of A.J. Schwartz's "conventional wisdom" that price stability would yield financial stability. Using simple correlations and VAR and Dynamic Conditional Correlations, we reject the hypotheses that price stability is positively correlated with financial stability and that the correlation is stable over time. The latter result and the analysis of the determinants of the link between price stability and financial stability cast some doubt on the appropriateness of the "leaning against the wind" monetary policy approach.

1. Introduction

Is financial stability correlated with price stability? This topical question matters for policy implementation, since most of the central banks have become responsible for financial stability supervision in the aftermath of the global financial crisis. In spite of the subject's relevance, the literature on it is surprisingly limited, and mostly dominated by "conventional wisdom" on the links between monetary and financial stability summarized by Borio and Lowe (2002, p. 27): "A monetary regime that produces aggregate price stability will, as a by-product, tend to promote stability of the financial system". The conventional wisdom originates in Schwartz (1995), who emphasizes both a micro and a macro channel in the link between inflation and asset prices. On the micro side, she relates price instability to inflation distortion, growing uncertainty, shortened investment horizons, and governments' nominal gains. All these dimensions produce financial instability. On the macro side, she discusses the impact of price instability on the value of collateral and on financial risk. Inflation would then encourage speculative investment, leading to financial instability.

The link between financial and price stability is also relevant for the ongoing theoretical debate on the conduct of monetary policy, in particular on monetary policy instruments and objectives (Smets, 2014; Woodford, 2012). Assuming that the conventional wisdom is true, a central bank focusing on price stability would then

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also contribute to financial stability (Bordo and Wheelock, 1998). Although this conventional wisdom has not been explicitly adopted by central banks, it was *de facto* embedded in the conduct of monetary policy since the 1990s, which has been strongly influenced by the Jackson Hole Consensus stipulating that central banks are primarily assigned the price stability objective and only implicitly the financial stability objective.[1] The prevailing consensus in the literature on central banks and monetary policy has indeed disregarded the issue of financial instability.[2] Following Bernanke and Gertler (1999, 2001), asset prices had to be considered in monetary policymaking only to the extent that they were threatening the price stability objective. The recent financial turmoil has cast some doubt on these issues. The dotcom bubble and the subprime crises have indeed erupted in a context of low and stable inflation – the so-called "Great Moderation" – whereas the role of central banks in promoting price stability has been emphasized (Stock and Watson, 2003, or more recently Mumtaz and Surico, 2012). Since then central banks have *de facto* or *de jure* given the financial stability objective a status close to that of the price stability objective (Cukierman, 2013).[3] There is consequently a need for an in-depth analysis of the link between price stability and financial stability. To our knowledge, there is no recent and comprehensive empirical assessment of this link in the literature.[4]

The objective of this paper is to fill this gap and to investigate evidence on the link between price and financial stability since 1993 for the United States (US) and since 1999 for the Eurozone (EZ). It must be stressed that we do not address the issue of the causality because the conventional wisdom is compatible with several causation approaches. The estimation period covers a stable period – the Great Moderation – as well as a more volatile period – the Global Financial Crisis – which makes it possible to assess the effect of changing economic conditions on the empirical relevance of the conventional wisdom. Furthermore, covering the years between 1993 (or 1999) and the Global Financial Crisis is all the more relevant since most central banks focused only on price stability during this period, despite a growing debate on the nexus between financial and monetary stability (Borio and Lowe, 2002). The empirical approach developed in this paper may then provide some critical insights into the existing beliefs that prevailed *de facto* during the Great Moderation.

We test the null hypothesis that price stability is positively correlated with financial stability and that this relationship is stable over time. This task is made difficult because there is no precise definition of financial instability. One can distinguish at least two recent approaches. First, Borio (2012) and Drehmann et al. (2012) seek to characterize financial cycles by using ad-hoc frequency-based filters. The identification of financial cycles may be useful to characterize periods of boom and bust, but such an approach goes beyond what may be deemed financial instability. Second, the indices of financial stability constructed by the ECB and the St Louis Fed can be used to give composite information on a wide range of financial instruments. We adopt this second approach and make use of both indices, plus asset price variables for robustness purposes.

The link between financial and price stability is analyzed through three different methods. We start with simple correlation analysis – while unsophisticated, this has the merit of simplicity and clarity – using no statistical or theoretical manipulation of the data. We then test our hypothesis using a simple VAR model, using as endogenous variables industrial production, inflation, asset prices and various financial stability indicators. Finally, following Engle (2002), we estimate a time-varying measure of correlations based on dynamic conditional correlation (DCC). The three methods provide converging results. We reject the hypothesis that price stability is positively correlated with financial stability and do not find evidence in support of the conventional wisdom. None of the three empirical methodologies shows a stable positive link between financial and price stability. Consequently, the main policy implication of this paper is that, as the link between price and financial stability is unstable and not positive, the "leaning against the wind" strategy is hard to justify on empirical grounds.

The rest of this paper is structured as follows. Section 2 presents the related literature. Section 3 describes the data and section 4 the empirical methodologies and the results. Section 5 investigates the determinants of the link between financial and price stability and discusses the appropriateness of the "leaning against the wind" monetary approach in the Eurozone and the US. Section 6 concludes.

2. Related literature

2.1. The conventional wisdom

The "conventional wisdom" (also known as the Schwartz hypothesis) is based on relatively few contributions. Besides the work of Schwartz (1995), the idea that price and financial stability exhibit a positive correlation is supported by Bordo et al. (2001) and Issing (2003). Schwartz (1995) mainly focuses on the banking sector: "the fact remains that price instability undermines sound banking. It contributes to financial risk" (p. 39), and she goes beyond debt-deflation à la Fisher (1933) as she relates the end of price (hence financial) instability to sound monetary policy. Woodford (2012) also argues that monetary stability eliminates numerous sources of financial instability such as wage-price spirals. Nevertheless, to our knowledge, only a few papers are specifically dedicated to an empirical assessment of the conventional wisdom. Bordo and Wheelock (1998) and Bordo et al. (2001) conclude that unanticipated movements in the price level and inflation rate have contributed historically to financial instability in the US, ever more so between 1870 and 1933, or in the 1980s and 1990s. Furthermore, Hardy and Pazarbasioglu (1999) and Dermirguc-Kunt and Detragiache (1997) find that countries with high levels of inflation are more prone to financial crises.

Before the global financial crisis, the conventional wisdom had already come in for criticism, e.g. by Borio and Lowe (2002), Rajan (2005), White (2006) and Leijonhufvud (2007). These authors claimed that monetary stability could lead to financial instability in that it sometimes allows low interest rates ("cheap money"), favoring projects with a high level of risk. The argument is also raised by Taylor (2009), who presents a counterfactual dynamic of housing market prices from 2001 to 2006. He argues that if monetary policy rates had not been excessively low, with regard to what is implied by a Taylor rule, the housing boom would have been avoided and no bust would have occurred. These different authors also point out that major economic and financial crises were not preceded by inflationary pressures. This is the "paradox of credibility" according

[1] Financial stability here is understood in a narrow sense: central banks are meant to avoid a liquidity squeeze in the interbank market through their role as lenders of last resort (LLR). Going a step further, Goodhart (2011) recalls that central banks have historically pursued three objectives or functional roles: price stability, financial stability and support for State financing.

[2] This issue is not dealt with in the influential papers of Clarida et al. (1999) or Svensson (1999).

[3] For instance, the Financial Services Act 2012 in the UK established a Financial Policy Committee (FPC) and gave the Bank of England an explicit financial stability objective.

[4] Klomp and de Haan (2009) analyze the role of central banks in promoting financial stability but they focus on central bank independence, invoking a political economy dimension rather than the link through price stability.

to which central banks have gained credibility in curbing inflation, which has ultimately led to an increase in the vulnerability of the financial system and then to financial instability. It therefore seems that inflation is not a good predictor of banking or financial crises.

2.2. Theoretical linkages between price and financial stability

In her seminal work, Schwartz (1995) relates price instability to financial instability through inflation distortions, on one side, and collateral value and increased financial risk, on the other side. Bordo and Wheelock (1998) find no specific mechanism explaining the conventional wisdom: on the one hand, financial instability may result from monetary disturbances, if the unexpected inflation resulting from monetary contractions or expansions leads to banking panics. On the other hand, the correlation between financial and price stability may also be the consequence of financial fragility when, in periods of economic boom, confidence improves and leverage increases, leading to over-indebtedness. Asset prices also increase, but not necessarily the price of goods and services. If inflation increases, it may even inflate the bubble, as it leads to a decrease in the real cost of borrowing. The process ends when agents are unable to repay their debt because of a negative exogenous shock or a tightening of monetary policy. The ensuing debt-deflation process leads to price and financial instability fueling each other. In a similar vein, Adrian and Shin (2009) and Rajan (2005) suggest that, with low inflation, the search for high yields leads to a rise in risk-taking.

Financial instability may have a direct effect on the level of economic activity, and on price stability, through different channels. Gilchrist and Leahy (2002) identify a wealth effect as, during asset price booms, wealthier agents consume more and increased consumption has a direct and positive impact on inflation. This channel also works in the other way: in periods of high financial stress, when asset prices drop, economic agents are more constrained and tend to consume less. A similar channel can be identified via Tobin's Q theory of investment. During periods of financial stress, firms are less likely to find financing sources, and therefore invest less. Finally, the financial accelerator of Bernanke and Gertler (1989) also plays a role. A financial instability shock induces a fall in asset prices that deteriorates the balance sheets of economic agents and their net worth. Agents are less likely to borrow and thus to invest. This situation leads to a vicious cycle, the financial accelerator, of decreasing asset prices, tightening financing conditions, and declining economic activity and prices.

2.3. Implications in terms of policy strategies

The (assumed positive) correlation between price and financial stability has become a crucial issue for monetary policy. Some critics of the conventional wisdom argued that, in addition to their role as LLR, central banks should also be given the task of seeking "financial stability". These discussions are related to the Tinbergen principle postulating that *N* instruments are needed to achieve *N* objectives. This branch of the literature is abundant (see Disyatat, 2010), but it does not seriously challenge the "conventional wisdom". Indeed, Blanchard et al. (2010) explain that no change is required in the policy reaction function, except better cooperation with the supervisory body. Woodford (2012) proposes that the central bank should embrace a flexible inflation targeting strategy, while White (2009) calls for a "leaning against the wind policy".

At least three views on the relationship between financial stability and monetary policy (then price stability via monetary policy) can be found in the literature (Smets, 2014): a modified Jackson Hole consensus in the vein of Blanchard et al. (2010), where central banks still primarily focus on price stability, whereas financial stability is tackled with an additional instrument – the macroprudential tool; Brunnermeier and Sannikov's (2014) intermediation theory of money, arguing that financial and price stability cannot be distinguished, so that monetary policy should aim at stabilizing the macro-financial environment and should be strongly coordinated with financial stability policy; and the "leaning against the wind" approach of White (2009) and Woodford (2012).

We focus our discussion on the last view, as the empirical analysis below allows us to assess its policy relevance. Woodford (2012) builds a simple New Keynesian model in which financial frictions, identified with the spread between safe and risky borrowers, reduce the average marginal utility of income, for a given level of real activity. Thus, larger credit frictions impact both the IS curve (reducing aggregate demand for given inflation), and the Phillips curve (increasing inflationary pressures for given levels of the output gap). Financial frictions may increase with an endogenous probability, which is increasing with the level of leverage of the economy; the latter in turn is positively related, via the level of intermediation, to the output gap. With completely exogenous credit frictions, it is possible to show that inflation-targeting remains the optimal strategy for central banks, and that credit frictions play the same role as cost-push shocks: increasing financial instability yields inflationary pressure, and requires the central bank to increase interest rates to stabilize prices.

Woodford then shows that when the probability of crises is endogenous, and related to the level of leverage in the economy, flexible inflation-targeting remains the optimal monetary policy strategy. Nevertheless, if the risk of financial crisis increases beyond a certain threshold, then it may be optimal for the central bank to "lean against the credit boom", increasing rates beyond the level that would be required by the macroeconomic variables. As a consequence, the central bank could be led to undershoot both the inflation rate and the output gap objectives.

While Woodford acknowledges that the spread between his stylized model and practical guidelines for central bank action remains wide, his paper highlights the theoretical channel between financial stability and price stability, which mostly goes through an augmented version of the Phillips curve. To summarize, Woodford concludes from his analysis that (a) monetary policy impacts financial and price stability in the same direction, thus lending support to the conventional wisdom; this is especially true in normal times, when the impact of financial crisis probabilities on the conduct of monetary policy is negligible; and (b) that when the risk of financial crisis increases substantially, it may become optimal to undershoot the inflation objective (i.e. so whenever facing the risk of financial instability, it is better to err on the restrictive side). Only in situations of high risk does a possible conflict between the two objectives arise, which in turn calls for macroprudential policy to take care of the objective of financial stability, while the central banks remain focused on price stability. Woodford's model, therefore, reaches the conclusion that standard inflation-targeting strategies are only exceptionally altered by the possibility of financial instability, and that the latter problem is best dealt with by appropriate regulation.

Gali (2014) reaches a different conclusion. In a rational-expectations setting, he argues that a bubble has two different components that react differently to a change in short-term interest rates: the fundamental component and the bubble (or self-fulfilling) component. The fundamental component clearly confirms the usefulness of the "leaning against the wind" monetary policy: a higher nominal short-term interest rate will dampen aggregate demand. The bubble component requires dampening *future* aggregate demand; hence it requires a lower short-term nominal interest rate. The optimal monetary policy depends on the relative size of the bubble component *vis-à-vis* the fundamental one. While his model does not incorporate credit or financial frictions, Gali warns against a "leaning against the wind" policy, and advocates further research on macroprudential policies.

3. Data

Our data set focuses on price and financial stability variables for the United States and the Eurozone over a period characterized by the "Great Moderation" and by the "Global Financial Crisis". We use monthly samples: 1993M12-2012M12 for the US and 1999M01-2012M12 for the EZ. The sample lengths are limited by the availability of financial stability indices. But this limitation allows focusing specifically on the link between price and financial stability during a period (from the beginning of the 1990s until 2007) when it was believed that the monetary regime had contributed to price stability, and by the same token to financial stability (Benati and Goodhart, 2010).[5]

As a measure of price stability, we alternatively use the consumer price index (CPI) and the GDP deflator (PGDP) in the US and in the EZ. The measure of financial stability is more controversial (Allen and Wood, 2006), because it is a polymorphous concept that may be related to the volatility of some asset prices, to the financial conditions of financial institutions or to the ability of the financial system to deal with shocks. No consensus has clearly emerged so far to provide a definition. In this paper we use the financial stability indicators constructed by the Federal Reserve of St Louis for the US and by the ECB for the EZ.

The St Louis financial stress index (STLFSI) measures the degree of financial stress in the markets and is constructed from 18 weekly data series: seven interest rate series, six yield spreads and five other indicators. Each of these variables captures some aspect of financial instability. Accordingly, as the level of financial instability in the economy evolves, the 18 data series are likely to move together.[6] The main assumption in the construction of this index is that financial stress is the most important factor in explaining the co-movement of these variables. Using a principal components analysis, it identifies this factor. The average value of the STLFSI is designed to be zero. Thus, zero represents normal financial market conditions. Values below zero suggest below-average financial market stress, while values above zero suggest above-average financial market stress.

The ECB's composite indicator of systemic stress (CISS) includes 15 raw, mainly market-based financial stress measures. These are split equally into five categories, namely the financial intermediaries sector, money markets, equity markets, bond markets and foreign exchange markets.[7] The CISS thus places relatively more weight on situations in which stress prevails simultaneously in several market segments. It is unit-free and constrained to lie within the interval [0,1]. Further details are given in Hollo et al. (2012).

The STLFSI and the CISS measure financial instability in the US and the EZ, but one may argue that their methodology is different and that they do not capture exactly the same concepts. Kliesen et al. (2012) classify the STLFSI as a *Financial stress index* and the CISS as a *Financial conditions index*, because the latter is constructed not only with financial data but also with economic data. Nevertheless, these indices are highly correlated.[8]

Table 1
Data description.

Variable	Definition	Source
us_cpi	Consumer Price Index for All Urban Consumers: All Items	FRED
us_pgdp	Gross Domestic Product: Implicit Price Deflator monthly interpolated (linear match)	FRED
us_fsi	St. Louis Fed Financial Stress Index	FRED
us_hous	Median Sales Price for New Houses Sold in the United States	FRED
us_stock	S&P 500 Stock Price Index	FRED
us_loan	Loans and Leases in Bank Credit, All Commercial Banks	FRED
us_m	Money Zero Maturity – Money Stock	FRED
us_indpro	Industrial Production Index	FRED
us_cbrate	Effective Federal Funds Rate	FRED
us_bonds	10-Year Treasury Constant Maturity Interest Rate	FRED
us_rbonds	Real 10-Year Treasury Constant Maturity Interest Rate	Authors' computation
ez_cpi	Euro area HICP – Overall index	ECB
ez_pgdp	Gross Domestic Product Deflator for the Euro Area, monthly interpolated (linear match)	ECB
ez_fsi	Euro area CISS, Systemic Stress Composite Indicator.	ECB
ez_hous	Euro area, Residential property prices, New and existing dwellings; Residential property in good & poor condition; Whole country	ECB
ez_stock	Dow Jones Euro Stoxx 50 Price Index – Historical close, average of observations through period	ECB
ez_loan	Euro area, Monetary and Financial Institutions (MFIs) reporting sector-Loans, Total maturity, Non-Financial corporations (S.11) sector	ECB
ez_m	M3 for the Euro Area	ECB
ez_indpro	Euro area Industrial Production Index, Total Industry (excluding construction)	ECB
ez_cbrate	Main refinancing operations interest rate	ECB
ez_bonds	Long-Term Government Bond Yields: 10-year: interest rate Main (Including Benchmark) for the Euro Area	ECB
ez_rbonds	Real Long-Term Government Bond Yields: 10-year interest rate	Authors' computation
oil	Spot Oil Price: West Texas Intermediate	FRED

This is reassuring because they are designed to measure similar effects, such as shocks that occur in financial markets and are transmitted to the real economy, or shocks that appear in the real economy and are propagated to the financial markets. Even if the CISS is composed with economic data, the dimensions measured by these data are strongly linked with the financial sector. As the financial data in the CISS are very similar to those used in the STLFSI, these indices are strongly alike.

Beyond the STLFSI and CISS, we also use other macroeconomic variables in our VAR and DCC specifications. All variables, except FSI, are in year-over-year growth rates. Table 1 presents the definitions and sources. Fig. 1 plots price and financial stability data, and Table 2 presents descriptive statistics.

[5] The description of the monetary regime since the early 1990s goes beyond the scope of this paper. See Bordo and Schwartz (1999) and Benati and Goodhart (2010) for historical detailed descriptions of the different monetary regimes.

[6] The latest STLFSI press release can be found at http://www.stlouisfed.org/newsroom/financial-stress-index. For more details on the construction of the STLFSI, see the Appendix to the January 2010 issue of the St. Louis Fed's *National Economic Trends*.

[7] The CISS index can be found at http://sdw.ecb.europa.eu/browse.do?node=9551138.

[8] Table A in the Appendix lists the constituents of each index.

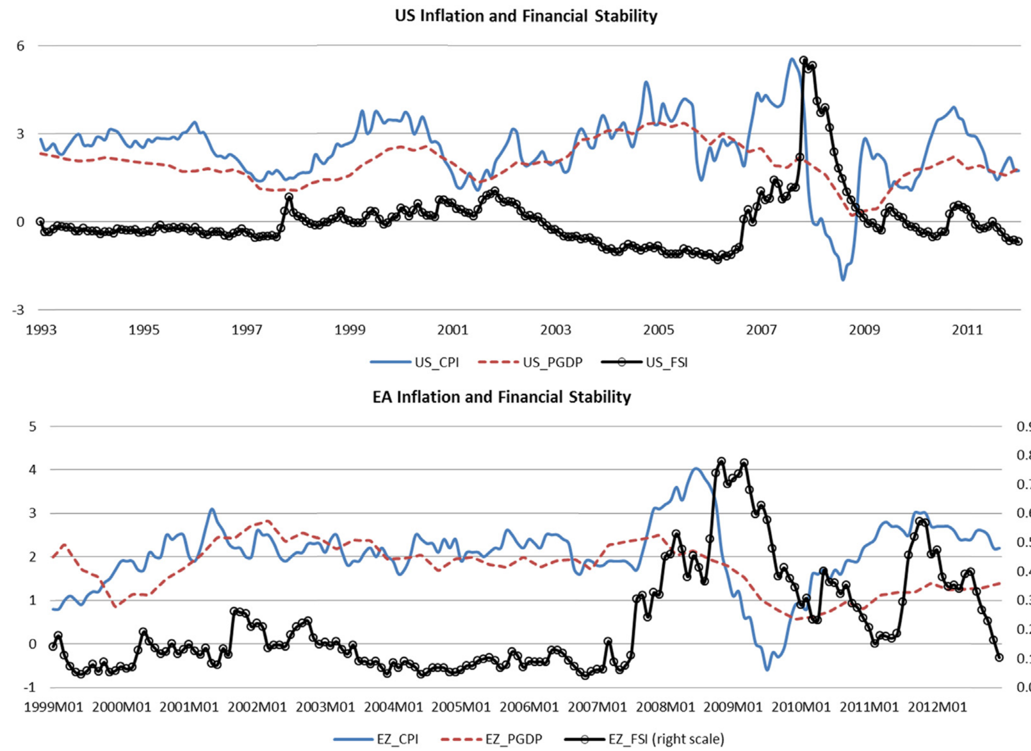

Fig. 1. Data.

Table 2
Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
us_cpi	229	2.48	1.13	−1.99	5.53
us_pgdp	229	1.99	0.66	0.22	3.38
us_fsi	229	0.03	1.00	−1.32	5.49
us_hous	229	3.63	6.11	−14.51	18.08
us_stock	229	5.15	17.76	−42.27	48.75
us_loan	229	4.08	4.13	−10.89	10.55
us_m	229	4.92	5.06	−5.96	19.28
us_indpro	229	2.25	4.58	−15.15	8.73
us_cbrate	229	3.21	2.23	0.07	6.54
us_bonds	229	4.73	1.44	1.53	7.96
us_rbonds	229	2.25	1.64	−1.92	5.55
ez_cpi	168	2.07	0.77	−0.60	4.00
ez_pgdp	168	1.74	0.57	0.57	2.82
ez_fsi	168	0.22	0.18	0.04	0.78
ez_hous	168	3.86	3.33	−4.36	7.52
ez_stock	168	1.19	23.38	−45.12	50.87
ez_loan	168	5.64	5.22	−3.92	15.11
ez_m	168	5.95	3.53	−2.07	12.62
ez_indpro	168	0.70	5.60	−21.44	9.05
ez_cbrate	168	2.52	1.19	0.75	4.75
ez_bonds	168	4.25	0.68	2.10	5.70
ez_rbonds	168	2.18	1.00	−0.19	4.69
oil	229	11.34	34.05	−58.97	136.76

4. Identifying the link between price and financial stability

We assess the link between price and financial stability through three methods: simple correlation, Vector AutoRegression (VAR) and dynamic conditional correlations (DCC). As the conventional wisdom does not provide any clear guidance on any structural relation between financial and price stability, these methods appear appropriate, as they focus on different statistical representations of the link between the two variables of interest and do not rely on specific theoretical foundations. The first method looks at the simple static correlation between levels of the two variables of interest. The second assesses how exogenous shocks to one of the variables of interest affect the level of the other. It adds information, relative to the simple correlation analysis, as VAR analysis can be used to take into account the past dynamics of price stability and financial stability and to identify shocks. These shocks are orthogonal to macro variables (industrial production, inflation and the central bank interest rate) and to variables possibly affecting price and financial stability (loans, monetary aggregate, housing prices and stock market prices). We therefore assess the response of financial stability (respectively, price stability) to a shock on price stability (respectively, price stability). The third method investigates the dynamic conditional correlation between price and financial stability based on the estimation of the two variables' conditional variances. This method presents two additional advantages relative to the static correlation and VAR analyses. First, the approach is time-varying, which improves the information relative to a static correlation approach. By construction, it accounts for the possibility that the link between price and financial stability may change over time. This is of paramount interest since, according to the "conventional view", the reduction in the volatility of inflation should have coincided with financial stability. Second, the approach is based on an estimate of the conditional volatility resulting from the GARCH model within a multivariate framework.

The DCC approach has been widely used in recent papers investigating notably the linkages between bond prices (Antonakakis, 2012), stock prices (Cai et al., 2009 or Bali and Engle, 2010), and stock and bond prices (Yang et al., 2009), with an extension to commodity futures (Silvennoinen and Thorp, 2013) and to commodity prices (Creti et al., 2013). Though Cai et al. and Yang et al. take into account the inflation environment, they do not study the linkages between financial and consumer prices per se.

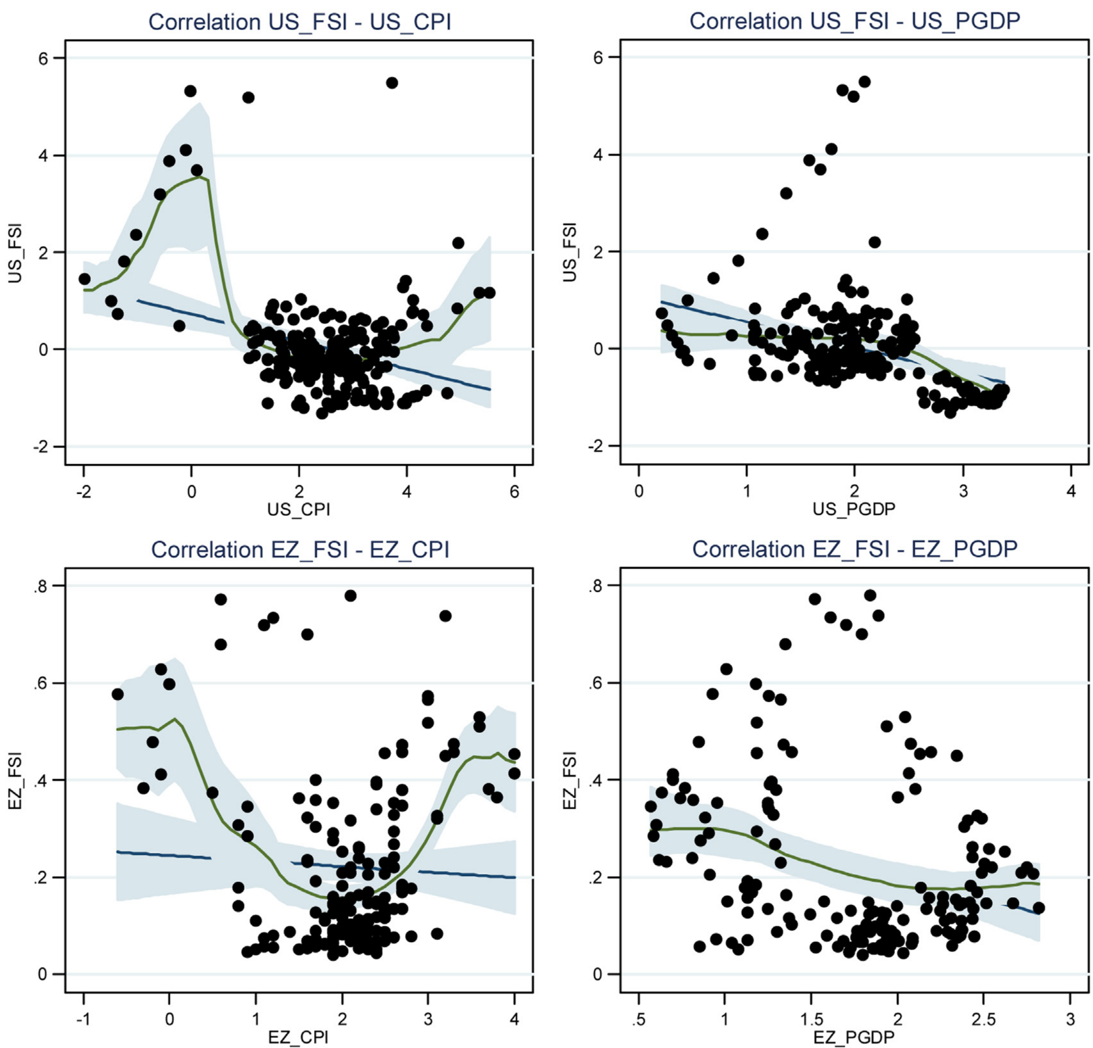

Fig. 2. Linear fit and Epanechnikov–Kernel smoothing lines (with 95% confidence bands).

4.1. *Simple correlation*

We first address our research question by computing correlation coefficients between inflation and financial stability indicators. Correlations are measured here for the whole sample and are presented in Table 3. Fig. 2 shows scatterplots of price and financial stability variables together with linear fit and Epanechnikov–Kernel smoothing lines. Whereas the conventional wisdom assumes a positive correlation between price and financial stability, we do not find such a result in our data. Results for the Eurozone show a negative correlation coefficient that is not significant with CPI, suggesting the absence of a relationship between price and financial stability in Europe since 1999. The correlation is found to be negative and statistically significant for the GDP deflator. The results for the United States are also inconclusive in terms of the conventional wisdom. They suggest that prices, measured either by the CPI or GDP deflator, and financial stability are either not or negatively correlated.

4.2. *VAR*

Our second exercise uses a VAR model estimate for the US and the EZ. We estimate a vector of 8 endogenous variables ordered in the following way: house prices, industrial production, consumer price index, loans to the non-financial sector, money supply, main central banks' interest rate, stock markets and the financial stability index [HOUS, INDPRO, CPI, LOAN, M, CBRATE, STOCK, FSI]. The identification of shocks is based on Cholesky decomposition. The ordering of the variables is supposed to mimic the speed of reaction of each series. Financial market variables are supposed to react the

Table 3
Correlation pairs.

	us_fsi	us_cpi	us_pgdp		ez_fsi	ez_cpi	ez_pgdp
us_fsi	1			ez_fsi	1		
us_cpi	−0.32(0.00)	1		ez_cpi	−0.05(0.52)	1	
us_pgdp	−0.34(0.00)	0.93(0.00)	1	ez_pgdp	−0.28(0.00)	0.39(0.00)	1
N		229		*N*		168	

Note: Significance level of each correlation coefficient in parenthesis.

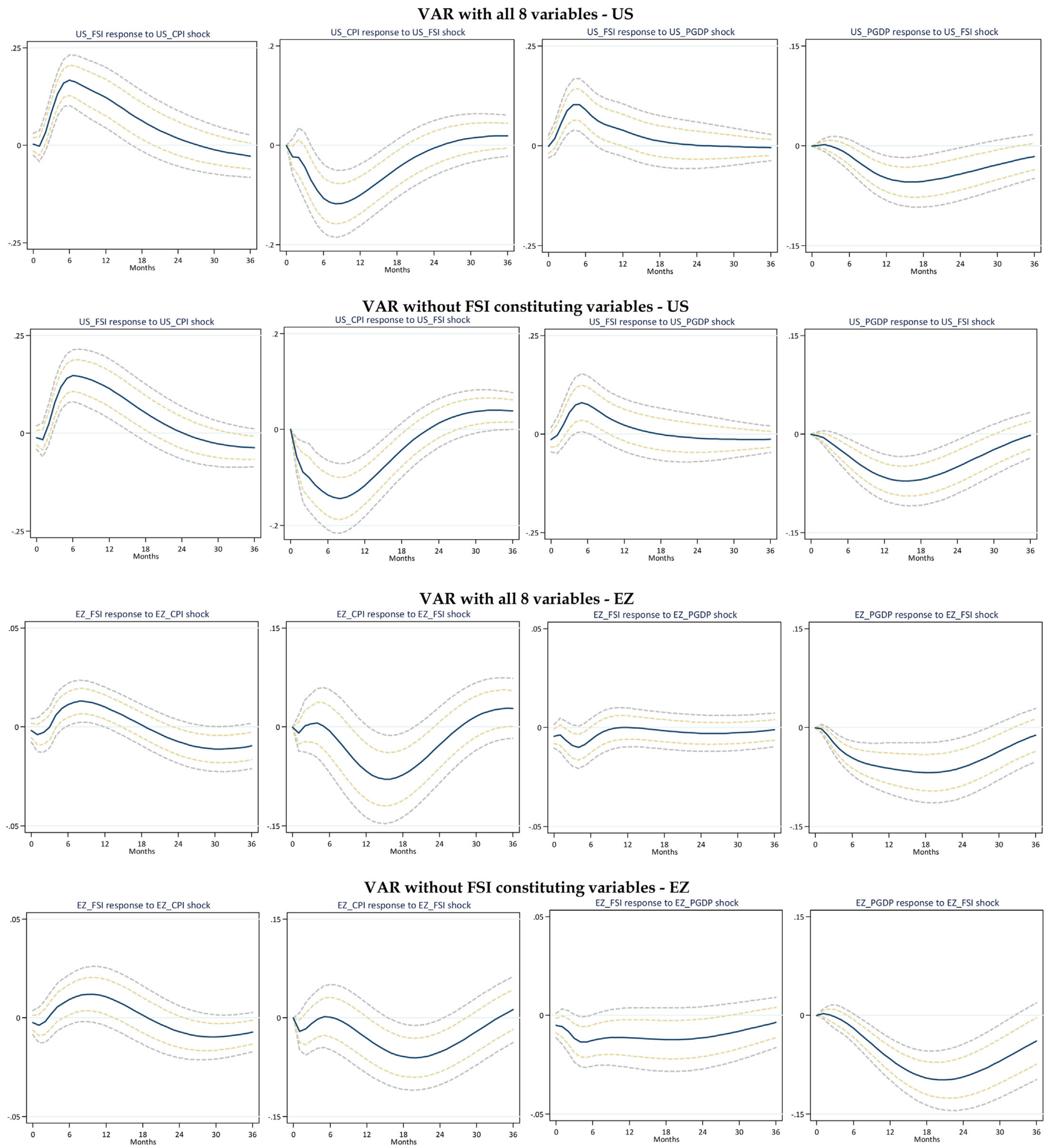

Fig. 3. IRFs.

fastest and macro variables the slowest. House prices are peculiar, a financial variable that adjusts slowly, notably because the price is not set daily on an organized market. Ultimately what matters the most to test our null hypothesis is the relative position of the CPI (or PGDP) and of the FSI, and it seems reasonable to assume that the FSI, which captures asset prices set daily on financial markets, reacts more quickly than the CPI. Moreover, we include some of the constituents of the financial stability index in the vector of endogenous variables in order to single out the most exogenous financial shocks orthogonal to housing or asset prices. However, as it could be argued that these constituents should not be included as they make the interpretation of the shocks more difficult, we also estimate our VAR model without the FSI constituting variables. Estimations are performed with 3 lags. The VAR model enables to take into account the past dynamics of each variable when assessing the correlation between price and financial stability. Hence, shocks to financial stability are interpreted as the unexpected component of FSI once the past dynamics of all the variables from the VAR and the current unexpected shocks on the other seven variables of the VAR have been taken into account.

As the focus of the paper is on the effect of financial stability on price stability and vice versa, Fig. 3 provides the corresponding impulse response functions (IRF) in both the US and the EZ. The results in the US are significantly asymmetric. Indeed, on the one hand an inflationary shock in the US increases financial instability. We isolate a positive link in this direction, which would be consistent with the macro side channel of the conventional wisdom. The impact is significant for more than 12 months when the shock is measured by CPI inflation and only for a few months when it is measured by the GDP deflator. On the other hand, a financial instability shock reduces inflation. Here the link is then negative. The shock on the financial stability index might reflect an increase in financial fragility or a financial crisis leading to a reduction of inflation and, in the worst case, to a debt-deflation process. The

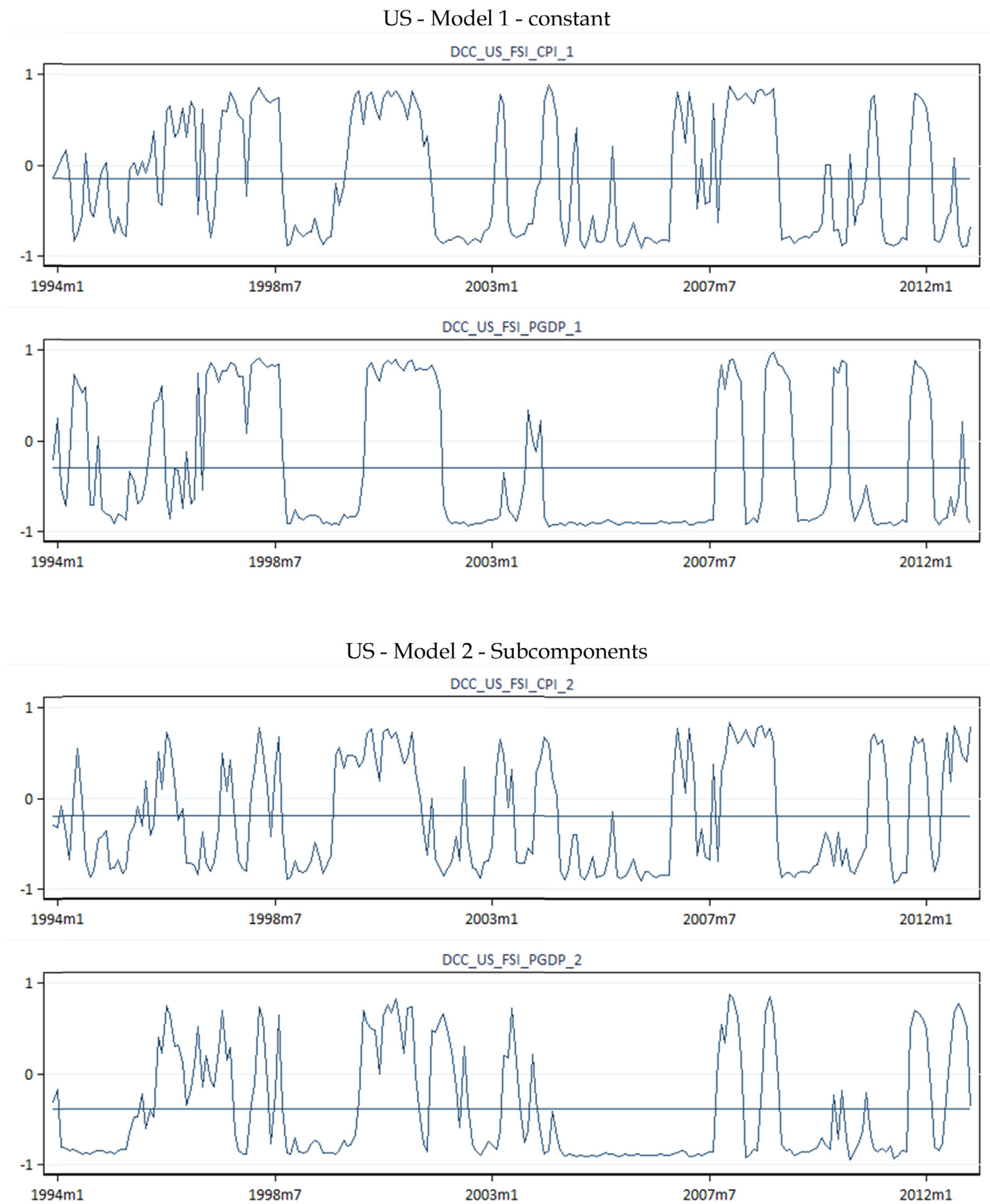

Fig. 4. Dynamic conditional correlations.

Note: Constant lines represent the average of the dynamic correlations.

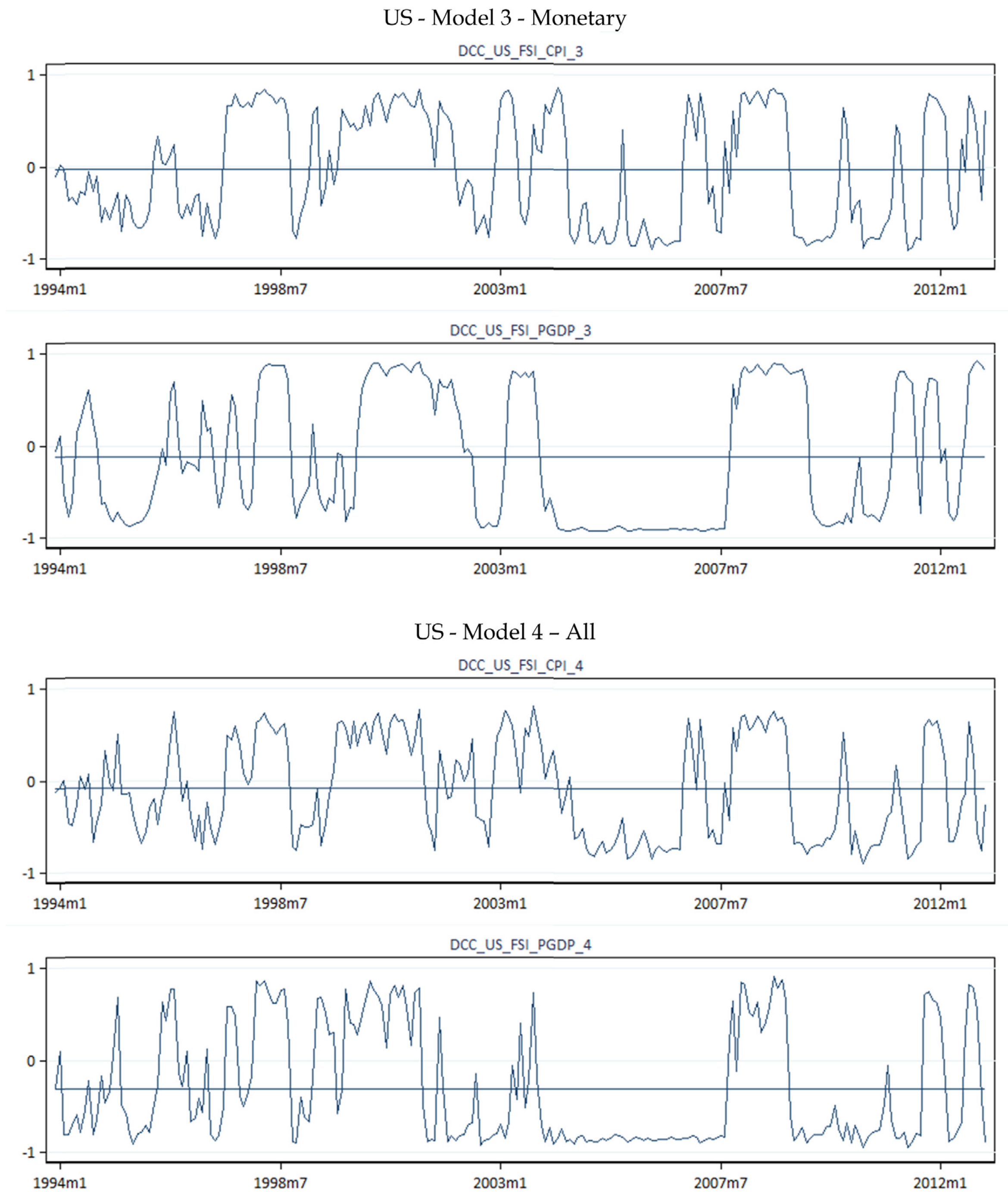

Fig. 4. (*Continued*).

results thus show evidence of a positive *and* a negative link between financial instability and price stability in the US. The results in the Eurozone indicate the same asymmetry, although the response of the financial stability variable to a shock to the GDP deflator is insignificant.

The IRF are also interesting as they show that a negative inflation shock has a positive effect on the FSI. This result can be related to the argument suggested by Rajan (2005) or Leijonhufvud (2007). During periods of low inflation and low interest rates, investors are eager to find high returns. This leads to the development of financial innovations, potentially riskier, and is conducive to financial instability.

4.3. *Dynamic conditional correlations*

The two previous methods failed to lend support to the conventional wisdom, in that no clear positive relationship emerges between indicators of price stability and indicators of financial stability. This could be due to the length of the time span that we considered (almost two decades for the United States, and slightly less for the Eurozone). Indeed, the existence of structural breaks could affect the results. Therefore, it is certainly worth resorting to a time-varying analysis of correlation to assess whether there have been sub-periods over which the conventional wisdom can be supported by data. To identify the possibly time-varying relationship

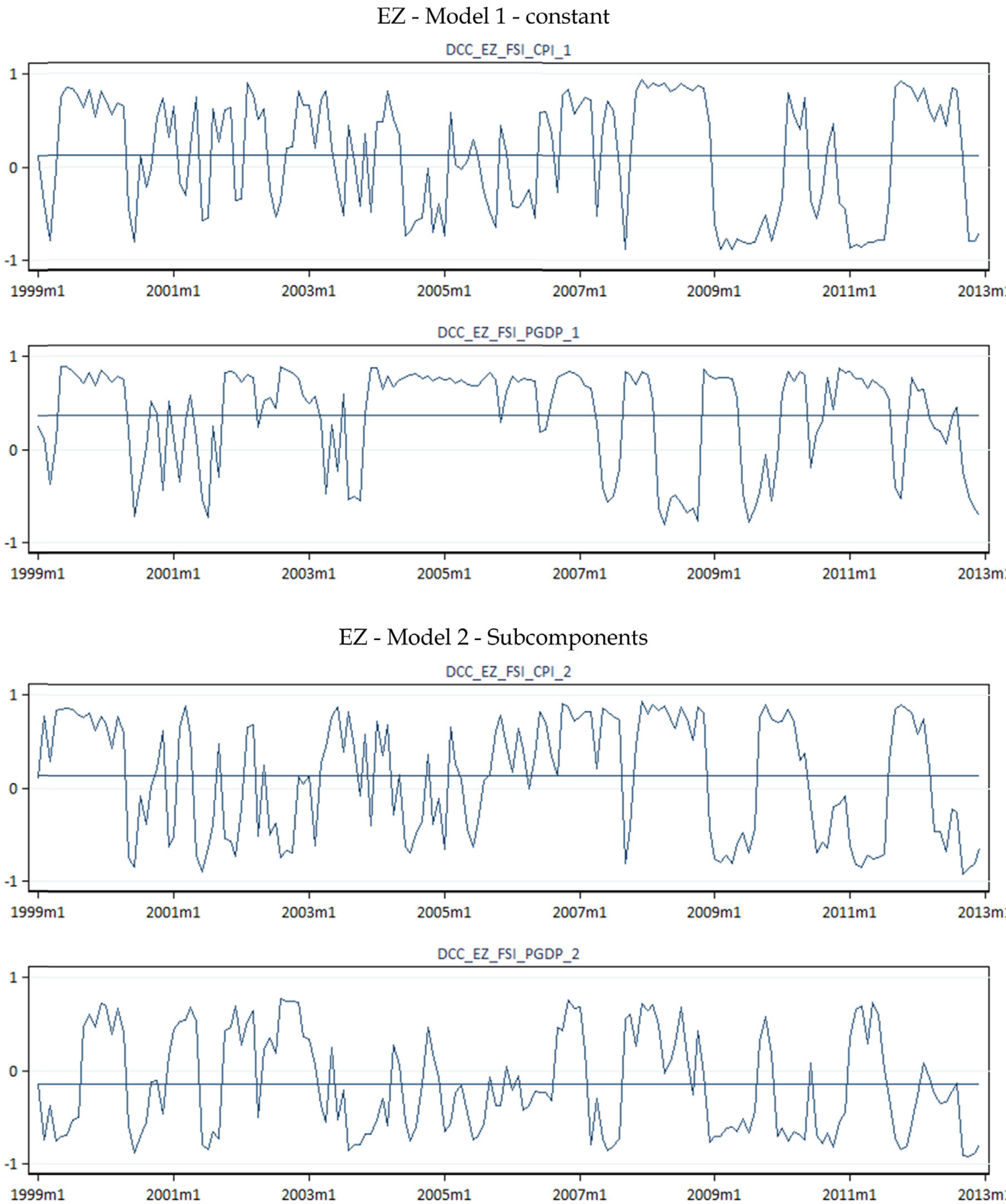

Fig. 4. (*Continued*).

between price and financial stability, we estimate a time-varying measure of correlation based on the dynamic conditional correlation (DCC) multivariate GARCH model of Engle (2002), in which the conditional correlation follows a GARCH(1,1) process.

The multivariate GARCH model is a specification of both the conditional mean and the conditional variance, where the variance of the residuals ε_t is a function of prior unanticipated innovations ε_t^2 and prior conditional variances σ_t^2. It is written as follows:

$$\begin{cases} Y_t = \beta . X_{t-1} + \epsilon_t \\ \epsilon_t = H_t^{1/2} \cdot v_t \\ H_t = D_t^{1/2} R_t D_t^{1/2} \end{cases}$$

where Y_t is the vector of dependent variables (here CPI inflation and the financial stability index), X_{t-1} is the vector of independent variables, which contains lags of dependent variables and v_t is a vector of normal, independent and identically distributed innovations. D_t is the diagonal matrix of conditional variances. In the bivariate case of the model describing CPI inflation and the financial stability index, the matrix is simply:

$$D_t = \begin{pmatrix} \sigma_{1,t}^2 & 0 \\ 0 & \sigma_{2,t}^2 \end{pmatrix}$$

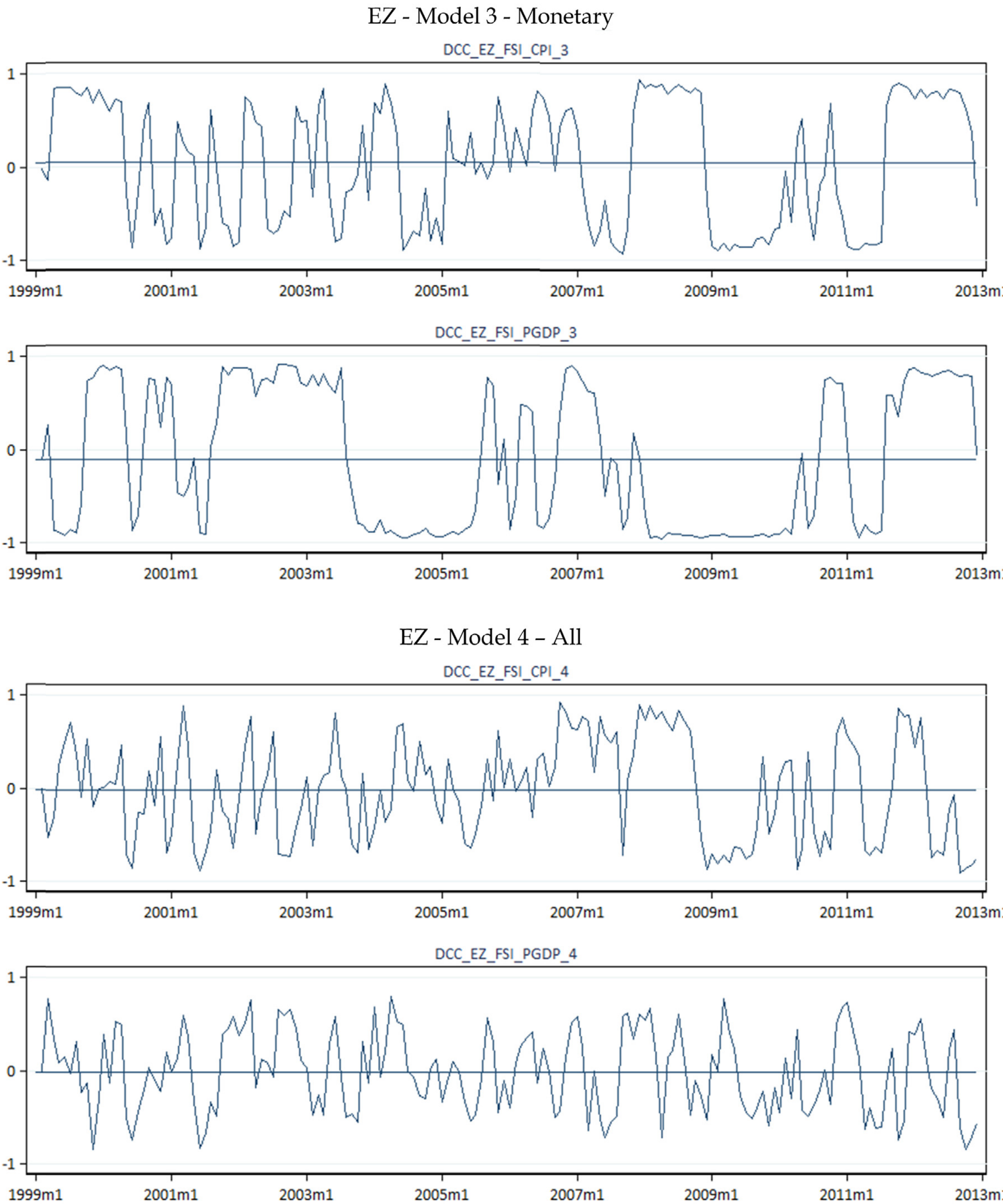

Fig. 4. (*Continued*).

Each conditional variance evolves according to a GARCH(1,1) model:

$$\sigma_{i,t}^2 = \gamma_0 + \gamma_1 \cdot \sigma_{i,t-1}^2 + \gamma_2 \epsilon_{i,t-1}^2$$

R_t stands for the matrix of quasi-correlations:

$$R_t = \begin{pmatrix} 1 & \rho_{21,t} \\ \rho_{12,t} & 1 \end{pmatrix}$$

and the conditional quasi-correlations are given by the following relation:

$$\begin{cases} R_t = diag(Q_t)^{-1/2} \cdot Q_t \cdot diag(Q_t)^{-1/2} \\ Q_t = (1 - \lambda_1 - \lambda_2)R + \lambda_1(\tilde{\varepsilon}_{t-1} \cdot \tilde{\varepsilon}_{t-1}') + \lambda_2 \cdot Q_{t-1} \end{cases}$$

where R is the unconditional covariance of the standardized residuals $\tilde{\varepsilon}_t$. γ_1 and γ_2 are parameters, governing the dynamic of conditional correlations, to be estimated. If $\gamma_1 = 0$ and $\gamma_2 = 0$, the model boils down to a constant conditional correlation model.

The DCC-GARCH model (see Engle, 2002) can be viewed as a multivariate representation of a univariate GARCH process in

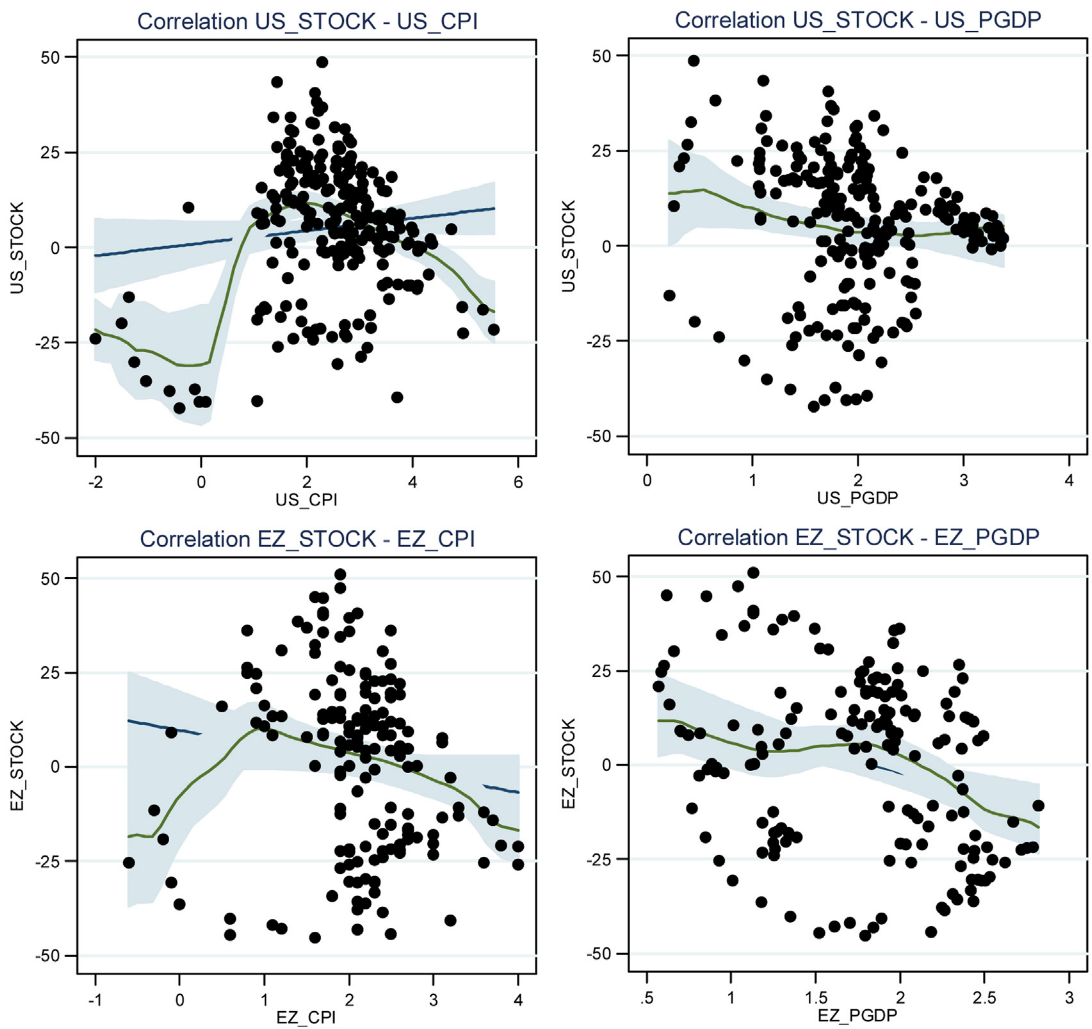

Fig. 5. Robustness – linear fit and Epanechnikov–Kernel smoothing lines (with 95% confidence bands).

which dynamic covariance is computed from conditional variance. The procedure involves two steps: first, estimating the conditional volatility of each individual series and, second, capturing dynamics in the covariance of the standardized residuals from the first stage procedure and using them as inputs to estimate a time-varying correlation matrix. When interpreting the results, one has to keep in mind that the DCC matrix is a weighted average of the unconditional covariance matrix of the standardized residuals, and of parameters that govern the dynamics of conditional quasi-correlations. The DCC matrix is not the unconditional correlation matrix, and for this reason it is generally labeled “quasi-correlations” (see Aielli, 2013; Engle, 2009).

We estimate four different DCC-GARCH models for inflation and financial stability:

1. A specification with a constant only and a dummy for the global financial crisis. Here financial stability and inflation are therefore determined by a constant term. It is the most parsimonious model. For the equation explaining inflation, this boils down to the case where inflation is equal to a target plus an error term. There is no link between price and financial stability except in the variance-covariance matrix.

Table 4
DCC quasi-correlation coefficients.

Variable	Coef	Robust SE	*p-value*
US			
CPI – FSI (model 1)	−0.30	0.74	0.68
PGDP – FSI (model 1)	−0.44	0.16	0.01
CPI – FSI (model 2)	−0.17	0.16	0.28
PGDP – FSI (model 2)	−0.45	0.17	0.01
CPI – FSI (model 3)	−0.05	0.25	0.85
PGDP – FSI (model 3)	−0.61	0.22	0.01
CPI – FSI (model 4)	−0.06	0.18	0.72
PGDP – FSI (model 4)	−0.46	0.15	0.00
EZ			
CPI – FSI (model 1)	0.19	0.15	0.21
PGDP – FSI (model 1)	0.63	0.13	0.00
CPI – FSI (model 2)	0.05	0.16	0.74
PGDP – FSI (model 2)	−0.17	0.15	0.25
CPI – FSI (model 3)	0.25	0.15	0.10
PGDP – FSI (model 3)	−0.25	0.19	0.19
CPI – FSI (model 4)	−0.22	0.15	0.13
PGDP – FSI (model 4)	0.05	0.15	0.72

Note: Dynamic conditional correlation multivariate GARCH models are estimated with the Huber-White estimator so standard errors are robust to some types of misspecification.

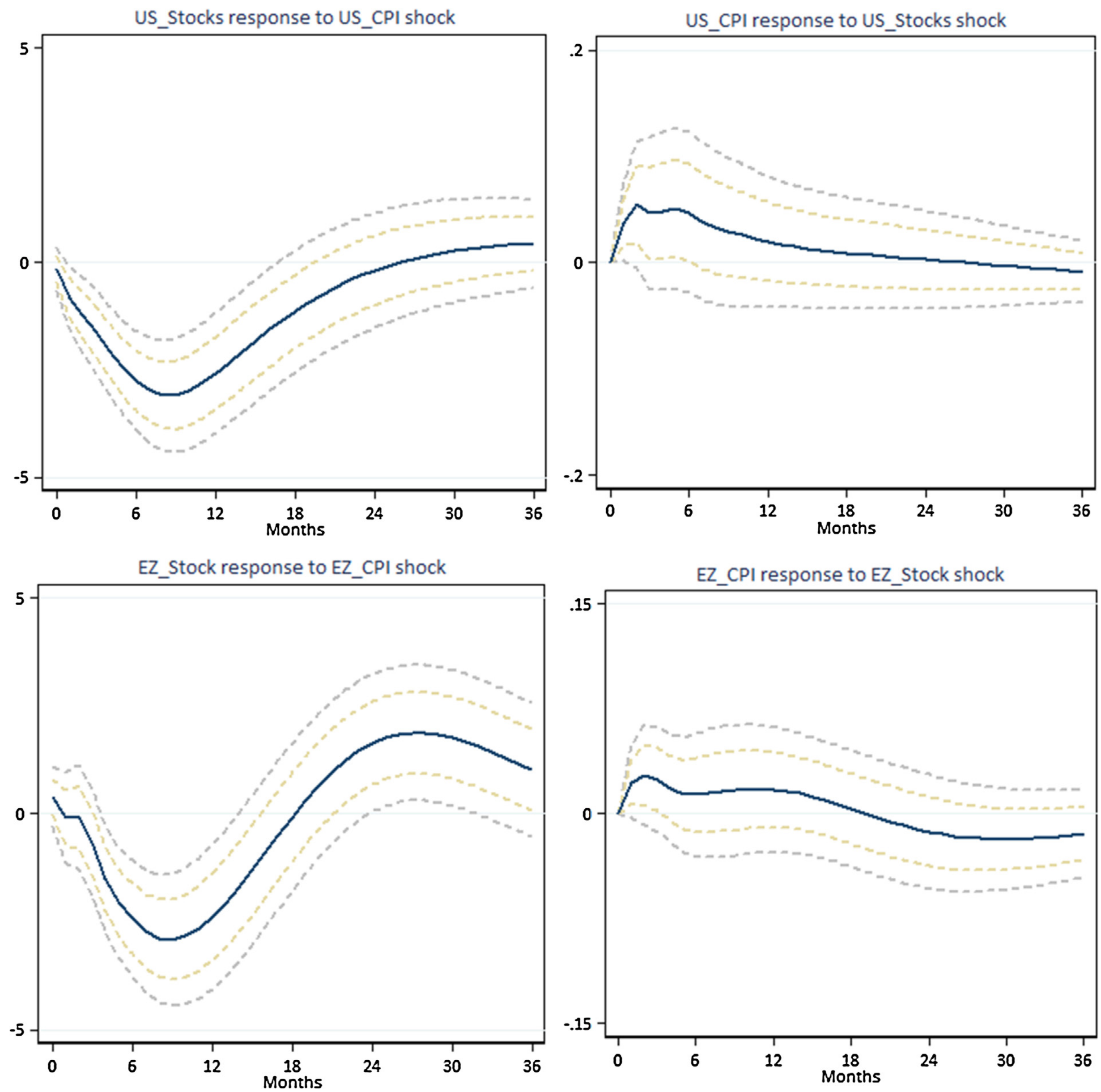

Fig. 6. Robustness – IRFs.

Note: Dotted lines represent 1 and 2 SE confidence bands.

2. A specification including lags of potential components of financial instability: housing prices, stock market prices, volumes of loans to the private sector in the vein of Bordo et al. (2001).
3. A specification including policy variables: the central bank interest rate and the monetary aggregate.
4. A specification including all the variables of models 2 and 3.

Though the aim of this approach is to provide dynamic correlations, the constant quasi-correlation coefficients of conditional variances give a first picture of the relation between the volatility of price and the volatility of the FSI, which may be compared to simple correlations. They are shown in Table 4. The results are broadly in line with simple correlation coefficients. In the US, quasi-correlation coefficients are negative, but not statistically significant for the CPI. In the case of the Eurozone, the results are even less clear-cut. Quasi-correlations are sometimes positive (3 out of 4 models for the CPI and 2 out of 4 for the PGDP) and sometimes negative. These coefficients are nevertheless rarely significantly different from zero. The only exception is the quasi-correlation between the PGDP and FSI in the first model (significantly positive) and the CPI and FSI in model 3, also positive but only at the 10% threshold.

The dynamic correlations for each specification and for the two indicators of inflation are plotted in Fig. 4. The solid constant line is the average of the dynamic correlations. These results indicate that the correlation between financial and price stability is highly volatile over the sample and does not present any stable empirical regularity. It can be either positive or negative for several months, and then rapidly switch sign. This is true both in the United States and in the Eurozone, and regardless of the model considered. The conventional wisdom, according to which price and financial stability go hand in hand, is clearly not confirmed by the DCC empirical analysis, at least over the two periods considered here: the Great Moderation and the Global Financial Crisis. As a consequence, it is

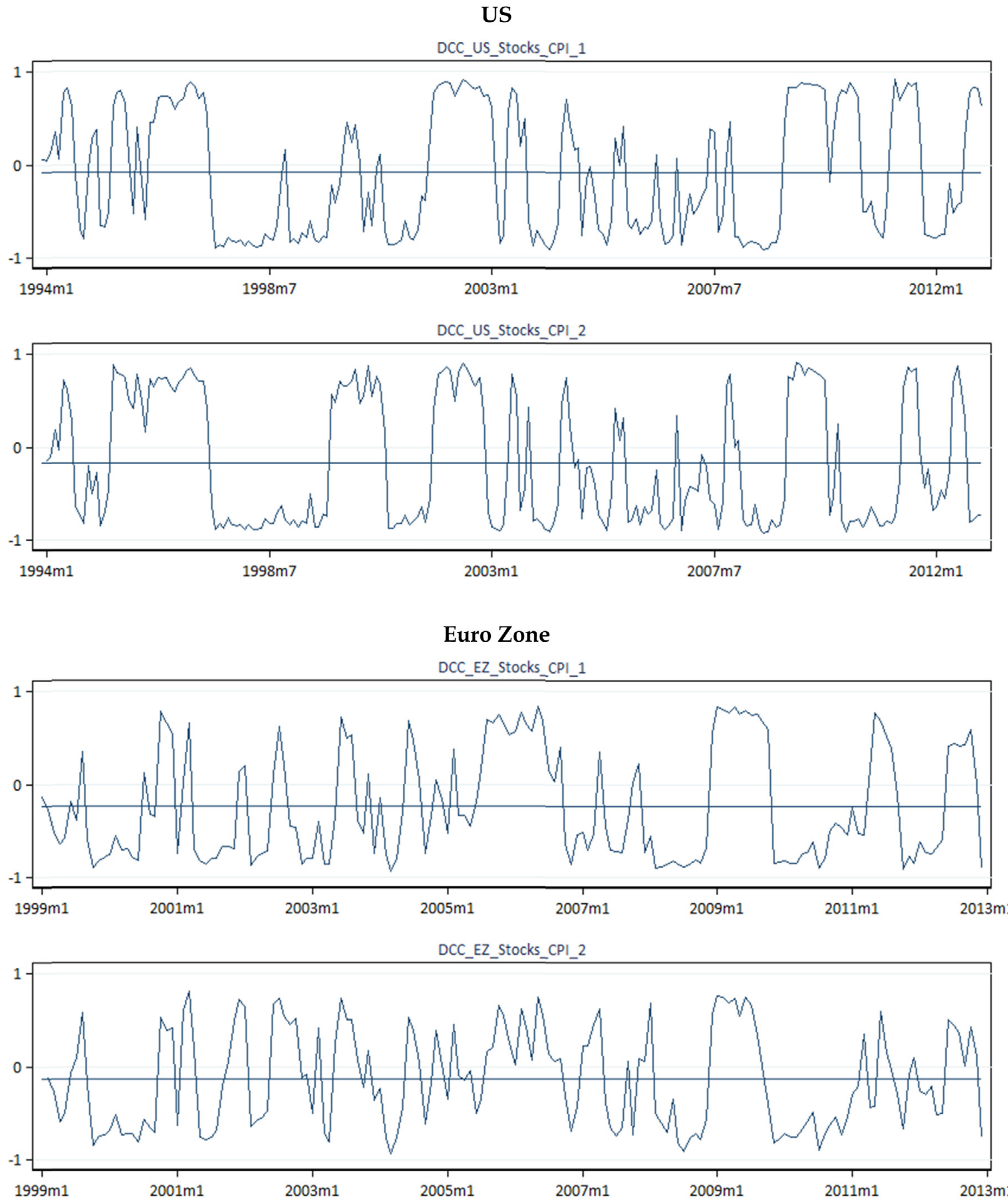

Fig. 7. Robustness – DCC.

Note: Constant lines represent the average of the dynamic correlations.

Table 5
Correlation pairs.

	us_stock	us_cpi	us_pgdp		ez_stock	ez_cpi	ez_pgdp
us_stock	1			ez_stock	1		
us_cpi	−0.31(0.00)	1		ez_cpi	−0.17(0.01)	1	
us_pgdp	−0.31(0.00)	0.93(0.00)	1	ez_pgdp	−0.44(0.00)	0.39(0.00)	1
N		229		*N*		168	

Note: Significance level of each correlation coefficient in parenthesis.

Table 6
Determinants of DCC.

	dcc_us_fsi_cpi_1			dcc_us_fsi_cpi_2			dcc_us_fsi_cpi_3			dcc_us_fsi_cpi_4		
	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS
us_fsi	**0.19*****		**0.22*****	**0.09***		0.10	**0.10***		**0.11****	**0.19*****		**0.21*****
	[0.05]		[0.07]	[0.05]		[0.06]	[0.05]		[0.06]	[0.04]		[0.08]
us_cpi	0.17***		0.16	0.18***		0.16*	0.16***		0.16*	0.13***		0.12*
	[0.04]		[0.10]	[0.04]		[0.10]	[0.03]		[0.09]	[0.03]		[0.06]
us_cbrate	0.10***	0.11***	0.11**	0.04	0.05	0.05	0.02	0.03	0.03	0.01	0.02	0.01
	[0.03]	[0.03]	[0.05]	[0.03]	[0.03]	[0.05]	[0.03]	[0.03]	[0.05]	[0.02]	[0.02]	[0.05]
us_m	**0.02****	**0.02****	0.02	**0.03*****	**0.03*****	**0.03***	**0.06*****	**0.06*****	**0.06*****	**0.03*****	**0.04*****	**0.04*****
	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
us_indpro	0.03**	0.01	0.03	0.03**	**0.02****	**0.03***	**0.04*****	**0.03*****	**0.04****	**0.04*****	**0.02****	**0.04*****
	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.02]
crisis	0.2	0.19	0.21	0.35**	0.25*	0.35	0.05	−0.03	0.07	−0.16	−0.13	−0.15
	[0.16]	[0.15]	[0.24]	[0.16]	[0.14]	[0.23]	[0.16]	[0.15]	[0.25]	[0.13]	[0.12]	[0.22]
_cons	−1.09***	−0.66***	−1.09***	−1.07***	−0.58***	−1.06***	−0.89***	−0.46***	−0.93**	−0.66***	−0.34***	−0.68**
	[0.19]	[0.15]	[0.37]	[0.18]	[0.13]	[0.34]	[0.18]	[0.14]	[0.37]	[0.14]	[0.11]	[0.28]
N	229	229	227	229	229	227	229	229	227	229	229	227
R^2	0.22	0.11	0.22	0.15	0.05	0.15	0.26	0.18	0.26	0.25	0.13	0.25

	dcc_ez_fsi_cpi_1			dcc_ez_fsi_cpi_2			dcc_ez_fsi_cpi_3			dcc_ez_fsi_cpi_4		
	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS
ez_fsi	1.46***		1.52	1.48***		1.23	1.32***		1.20	0.97**		1.21
	[0.45]		[1.04]	[0.49]		[1.15]	[0.50]		[0.77]	[0.46]		[0.75]
ez_cpi	0.12*		0.17	−0.17**		−0.22	0.29***		0.36**	0.02		−0.03
	[0.07]		[0.12]	[0.08]		[0.16]	[0.08]		[0.18]	[0.07]		[0.12]
ez_cbrate	0.03	0.11**	0.05	−0.06	0.00	−0.07	−0.14**	−0.05	−0.14	−0.05	0.00	−0.08
	[0.06]	[0.05]	[0.10]	[0.07]	[0.06]	[0.09]	[0.07]	[0.06]	[0.09]	[0.06]	[0.05]	[0.07]
ez_m	0.00	0.05**	−0.02	0.04	0.04	0.06	−0.02	0.05**	−0.03	0.03	0.06***	0.05
	[0.02]	[0.02]	[0.03]	[0.03]	[0.02]	[0.04]	[0.03]	[0.03]	[0.04]	[0.02]	[0.02]	[0.03]
ez_indpro	**0.03****	**0.03*****	**0.02***	**0.05*****	**0.02***	**0.05*****	**0.02**	**0.03*****	**0.01**	**0.04*****	**0.04*****	**0.05*****
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.02]
crisis	−0.44*	0.29*	−0.56	−0.49*	−0.05	−0.28	−0.69**	0.14	−0.73	−0.29	0.13	−0.29
	[0.24]	[0.17]	[0.53]	[0.26]	[0.18]	[0.52]	[0.30]	[0.21]	[0.49]	[0.24]	[0.14]	[0.34]
_cons	−0.44**	−0.57***	−0.41	0.22	−0.09	0.15	−0.20	−0.20	−0.23	−0.29	−0.41***	−0.26
	[0.20]	[0.18]	[0.37]	[0.24]	[0.21]	[0.39]	[0.26]	[0.24]	[0.54]	[0.19]	[0.15]	[0.24]
N	168	168	166	168	168	166	167	167	166	167	167	166
R^2	0.22	0.16	0.22	0.15	0.09	0.14	0.17	0.06	0.17	0.21	0.19	0.21

	dcc_us_fsi_pgdp_1			dcc_us_fsi_pgdp_2			dcc_us_fsi_pgdp_3			dcc_us_fsi_pgdp_4		
	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS
us_fsi	**0.32*****		**0.31*****	**0.16*****		0.14	**0.28*****		**0.32*****	**0.24*****		**0.27****
	[0.05]		[0.10]	[0.05]		[0.10]	[0.05]		[0.11]	[0.06]		[0.12]
us_pgdp	0.07		0.06	0.14**		0.14	0.19***		0.21	0.03		0.06
	[0.09]		[0.17]	[0.06]		[0.12]	[0.07]		[0.14]	[0.06]		[0.08]
us_cbrate	0.15***	0.16***	0.16***	0.06**	0.06**	0.07	0.05	0.06*	0.05	0.12***	0.13***	0.12**
	[0.03]	[0.03]	[0.06]	[0.02]	[0.02]	[0.05]	[0.03]	[0.03]	[0.06]	[0.02]	[0.02]	[0.05]
us_m	**0.03****	**0.04*****	0.02	**0.05*****	**0.05*****	**0.05*****	**0.07*****	**0.07*****	**0.07*****	**0.04*****	**0.05*****	**0.05*****
	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
us_indpro	**0.04*****	0	0.03	**0.04*****	0.02	**0.04***	**0.05*****	**0.01**	**0.06*****	**0.06*****	**0.03*****	**0.07*****
	[0.01]	[0.01]	[0.03]	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.02]
crisis	0.48***	0.65***	0.53**	0.33**	0.32**	0.39*	0.36*	0.39**	0.39	0.32**	0.47***	0.36
	[0.15]	[0.14]	[0.25]	[0.15]	[0.12]	[0.24]	[0.19]	[0.15]	[0.30]	[0.16]	[0.13]	[0.26]
_cons	−1.24***	−1.14***	−1.24**	−1.26***	−0.92***	−1.32***	−1.20***	−0.77***	−1.30***	−1.19***	−1.17***	−1.30***
	[0.29]	[0.12]	[0.52]	[0.20]	[0.10]	[0.38]	[0.24]	[0.13]	[0.45]	[0.20]	[0.10]	[0.34]
N	229	229	227	229	229	227	229	229	227	229	229	227
R^2	0.24	0.15	0.24	0.17	0.13	0.17	0.32	0.24	0.32	0.3	0.24	0.3

	dcc_ez_fsi_pgdp_1			dcc_ez_fsi_pgdp_2			dcc_ez_fsi_pgdp_3			dcc_ez_fsi_pgdp_4		
	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS
ez_fsi	0.28		0.35	0.01		0.55	−1.07		−0.78	1.19***		1.57***
	[0.63]		[0.85]	[0.51]		[1.18]	[0.65]		[1.58]	[0.43]		[0.42]
ez_pgdp	0.03		0.08	0		0	0.37*		0.36	0.23**		0.21**
	[0.12]		[0.19]	[0.15]		[0.23]	[0.21]		[0.51]	[0.11]		[0.09]
ez_cbrate	−0.22***	−0.20***	−0.20***	0.16***	0.16***	0.12	0.08	0.03	0.08	−0.07	−0.01	−0.09**
	[0.05]	[0.05]	[0.06]	[0.06]	[0.05]	[0.09]	[0.08]	[0.07]	[0.15]	[0.04]	[0.04]	[0.04]
ez_m	0.00	0.01	−0.01	0.00	0.00	−0.01	0.00	0.01	−0.01	−0.04**	0.00	−0.04**
	[0.02]	[0.02]	[0.03]	[0.03]	[0.02]	[0.05]	[0.03]	[0.03]	[0.07]	[0.02]	[0.02]	[0.02]
ez_indpro	**0.02***	**0.02***	**0.02***	**0.01**	**0.01**	**0.01**	**0.02****	**0.03*****	**0.02**	**0.01**	**0.00**	**0.01****
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.01]

Table 6 (*Continued*)

	dcc_ez_fsi_pgdp_1			dcc_ez_fsi_pgdp_2			dcc_ez_fsi_pgdp_3			dcc_ez_fsi_pgdp_4		
	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS
crisis	−0.49*	−0.40**	−0.52	0.04	0.04	−0.21	0.75*	0.13	0.57	−0.61***	−0.23*	−0.76***
	[0.29]	[0.15]	[0.45]	[0.29]	[0.14]	[0.56]	[0.40]	[0.23]	[0.69]	[0.20]	[0.12]	[0.21]
_cons	0.94***	0.95***	0.89**	−0.57*	−0.56***	−0.44	−1.00**	−0.32	−0.88	−0.06	0.10	0.00
	[0.24]	[0.18]	[0.37]	[0.29]	[0.17]	[0.33]	[0.42]	[0.26]	[0.75]	[0.20]	[0.14]	[0.14]
N	168	168	166	168	168	166	167	167	166	167	167	166
R^2	0.14	0.14	0.14	0.12	0.12	0.12	0.08	0.04	0.08	0.12	0.04	0.12

Robust standard errors in brackets using heteroskedastic and autocorrelation-consistent (HAC) robust variance estimates in order to mitigate potential generated dependent variable biases. The dependent variables are the dynamics conditional correlations (DCC) estimated in the previous section for the US and the EZ, for both the link between FSI and CPI or PGDP, using the 4 different models described in the related section. For each time series of correlation, we estimate the coefficients of (i) its potential determinants using OLS, (ii) removing FSI and CPI or PGDP that co-move with the dependent variable using OLS, and (iii) using IV-2SLS using the first two lags of FSI and CPI or PGDP and the first lag of the other independent variables as instruments. The *p*-value of the Hansen J statistic testing for the overidentification of all instruments suggest in all cases that the set of instruments is valid (uncorrelated with the error term). The *p*-value of the Kleibergen-Paap LM statistic testing for underidentification of all instruments is comprised between 0.01 and 0.20 and suggests that the instrument set is relevant and correlated with endogenous regressors.

* $p < 0.10$
** $p < 0.05$
*** $p < 0.01$.

hard to conclude that ensuring price stability can be a necessary or sufficient condition to achieving financial stability. Even more disturbing for the conventional wisdom is the fact that, when one uses models that include the US GDP deflator, the dynamic correlation is clearly negative over some periods. This is notably the case between the early 2000s and mid-2007. It is even more striking after 2003 when the DCC exhibits a clear and long-lasting negative relationship. This negative correlation appears in all the four specifications. During this sub-period of great moderation, inflation was contained and financial imbalances, notably in the housing market were growing. This result lends support to the paradox of credibility illustrated by Borio and White (2004) and White (2006) and to the change in risk perception or risk tolerance highlighted by Adrian and Shin (2009) and Rajan (2005). At a low inflation rate and low interest rate, the search for high yields and the expansion of banks' balance sheets lead to the rise of a risk-taking channel of monetary policy. Empirical evidence in this sense can be found in Altunbas et al. (2014) for 1100 banks from 15 countries. Section 5 will provide further insights into this issue.

4.4. Robustness with stock prices

For robustness purposes, we perform the same three exercises while replacing the FSI with stock market prices. Stock markets are already included in the FSI. The robustness analyses may then help to assess whether the results hold with an observable variable and a narrower definition of financial stability that would boil down to one peculiar asset price. Table 5 presents the results for the simple correlation coefficients. For the US, the results remain the same but in the Eurozone they are now clearly negative and significant. Scatterplots are shown in Fig. 5. IRFs from the VAR methodology are represented in Fig. 6. Inflation shocks still negatively affect the stock markets in the US and in the Eurozone, while shocks to stock prices have no significant effect on inflation. Finally, DCC results are presented in Fig. 7: in accordance with former DCC outcomes, they change sign several times over the period as a whole, showing that the stock prices-price stability nexus evolves over time. All robustness tests thus confirm the earlier results: empirically, there is no support for the conventional wisdom, neither in the Eurozone since 1999 nor in the US since 1993.

5. Determinants of the link between price and financial stability

As the final step in our analysis, we investigate whether the correlation between price and financial stability is explained by certain business cycle variables (the industrial production growth rate and a financial crisis dummy) and/or monetary policy variables (the central bank interest rate and the money aggregate growth rate), plus the FSI and the CPI separately. Finding determinants for this correlation might possibly shed light on the time-varying nature of DCC estimates. To this end, we compute different OLS and IV-2SLS estimations, using the DCC estimates from the four models described in Section 4.3 as the dependent variable.[9]

Because some of the independent variables co-move with, and underlie, the dependent variable, there may be an endogeneity issue. For both the US and the EZ, for each link between the FSI and CPI (or PGDP), and for each of the four models used, we therefore estimate three regressions: (i) including our 6 above-mentioned variables and using OLS, (ii) using OLS but removing the FSI and CPI (or PGDP) that co-move with the dependent variable, and (iii) including again all 6 variables and using IV-2SLS with the first two lags of FSI and CPI (or PGDP) and the first lag of the other independent variables as instruments. Moreover, given that the dependent variable is itself estimated in a previous step, this may cause underestimated standard errors (see Saxonhouse, 1976, for more details on the estimated dependent variable bias). We therefore apply the Huber-White sandwich estimator for heteroskedastic and autocorrelation-consistent (HAC) standard errors to mitigate this issue. The results are reported in Table 6.

In the US, several results can be identified. A higher financial instability (superior to its mean) is positively correlated with a higher (superior to its mean) DCC correlation between price and financial stability. The same result holds between, on the one hand, higher money supply and higher industrial production and, on the other hand, a higher DCC correlation, and to a lesser extent, between higher inflation and a higher DCC correlation. Turning to the Fed's interest rate, it appears that the conventional instrument has no clear-cut impact on the DCC correlation. Overall, the business cycle and the money supply emerge as the main drivers of the relationship between price and financial stability. When money growth is high, and the economy is booming, the correlation between price and financial indices is stronger. It seems therefore that, for the United States, there is some truth in the argument outlined above (Sections 2.2 and 2.3) that over-borrowing may be

[9] By construction, the DCC estimates are confined within the interval [−1; 1]. Antonakakis (2012) suggests applying a Fisher transformation, $log((1+\rho_{ij,t})/(1-\rho_{ij,t}))$, to ensure that the dependent variable is not restricted to that interval. In this paper, we only provide the results with the non-transformed variables, since the results are similar with the transformed variables. Estimates are available from the authors upon request.

one of the major channels through which inflation and financial instability are linked (via the booming economy and/or excessive liquidity provision). This result supports the argument of Brunnermeier and Sannikov (2014) in favor of better coordinating monetary policy with financial stability policy: a higher liquidity position during downturns may well help curtail the balance sheet constraints of banks at the expense of productive balance sheet-impaired sectors, hence generating greater financial instability.

For the Eurozone, the results are less clear-cut. Contrary to the US case, the financial stability index and money supply have no effect on the DCC correlation between price and financial stability; this is not really surprising, as EZ monetary authorities, especially before the current crisis, have been much more conservative than their Northern American counterparts in using liquidity injections as a policy tool. As in the US, central bank rates have a limited impact on the correlation: the ECB main refinancing operation (MRO) rate has no explanatory power on the DCC correlation between price and financial stability. The main result common to the US and the EZ is the positive effect of industrial production on the DCC correlation, suggesting that the link between price and financial stability may be associated with the business cycle.

It is interesting to notice, in conclusion, that the central bank interest rate plays no role in explaining changes in the DCC correlation between price and financial stability in either the US or the Eurozone. This, together with our main result that the correlation itself changes sign over time, casts doubts on the "leaning against the wind" strategy. As is clear from Woodford (2012), this strategy works only if the relationship is stable and positive, and if the interest rate instrument is effective in managing commodity and asset prices at the same time.

6. Conclusion

This paper describes the relationship between price and financial stability in the US and the Eurozone. The results are based on three methodologies: simple correlation coefficient, VAR and DCC-GARCH. Finally, we examine the determinants that are correlated with the DCC analysis. The main result is that no evidence supports the conventional wisdom in the US or Eurozone economies since the 1990s. None of the three empirical methodologies shows a robust positive link between financial and price stability and the time-varying approach indicates that the relationship is undoubtedly unstable.

This result suggests that the conventional wisdom is not empirically well grounded, at least over the period considered in the paper; this calls into question the relevance of policy prescriptions drawing from this "wisdom". Evidence showed that financial instability can develop even in a low inflation environment, as was the case during the Great Moderation. Price stability has not been a sufficient condition to promote financial stability. Consequently, financial stability should certainly be addressed independently of the objective of price stability. Some other results of this paper give grounds for a critical assessment of the "leaning against the wind" monetary policy in the Eurozone and the US. We show that the central bank interest rate has no effect on the computed correlation between financial and price stability. In contrast, variations in monetary aggregates have a significant impact on the computed correlation between financial and price stability, which lends support to the requirement of a better coordination of monetary policy and financial stability policy. Consequently, financial stability should be addressed with instruments other than simply the interest rate fixed by central banks. Macro and micro regulations may prove useful to fostering financial stability.

It is worth noticing, in conclusion, that the present empirical exercise focuses on a specific period when inflation has been moderate, and there may be other periods or other monetary regimes when the conventional wisdom might have been more relevant. The analysis of the determinants of the link between price and financial stability suggests that the correlation increases with money supply growth, and this may call for analyzing the stability of the price and financial stability relation across different monetary regimes over very long periods of time. This issue is left for further research.

Appendix A.

See Table A.1.

Table A.1
STLFSI and CISS constituents.

STLFSI		
	Interest Rates	• Effective federal funds rate • 2-year Treasury • 10-year Treasury • 30-year Treasury • Baa-rated corporate • Merrill Lynch High-Yield Corporate Master II Index • Merrill Lynch Asset-Backed Master BBB-rated
	Yield Spreads	• Yield curve: 10-year Treasury minus 3-month Treasury • Corporate Baa-rated bond minus 10-year Treasury • Merrill Lynch High-Yield Corporate Master II Index minus 10-year Treasury • 3-month London Interbank Offering Rate–Overnight Index Swap (LIBOR-OIS) spread • 3-month Treasury-Eurodollar (TED) spread 3-month commercial paper minus 3-month Treasury bill
	Other Indicators	• J.P. Morgan Emerging Markets Bond Index Plus • Chicago Board Options Exchange Market Volatility Index (VIX) • Merrill Lynch Bond Market Volatility Index (1-month) • 10-year nominal Treasury yield minus 10-year Treasury
CISS		
	Money market	• Realized volatility of the 3-month Euribor rate • Interest rate spread between 3-month Euribor and 3-month French T bills • Monetary Financial Institution's (MFI) emergency lending at Eurosystem central banks: MFI's recourse to the marginal lending facility, divided by their total reserve requirements
	Bond market	• Realized volatility of the German 10-year benchmark government bond index • Yield spread between A-rated non-financial corporations and government bonds (7-year maturity bracket) • 10-year interest rate swap spread
	Equity market	• Realized volatility of the Datastream non-financial sector stock market index • CMAX for the Datastream non-financial sector stock market index • Stock-bond correlation
	Financial intermediaries	• Realized volatility of the idiosyncratic equity return of the Datastream bank sector stock market index over the total market index • Realized volatility calculated as the weekly average of absolute daily idiosyncratic returns • Yield spread between A-rated financial and non-financial corporations (7-year maturity) • CMAX as interacted with the inverse price-book ratio (book-price ratio) for the financial sector equity market index
	Foreign exchange market	Realized volatility of the euro exchange rate vis-à-vis the US dollar, the Japanese Yen and the British Pound

Source: Hollo et al. (2012) and Federal Reserve Bank of St Louis (2010).

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